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WITH METALLURGICAL SECTION

# The Chemical Age

VOL LXVII 5 JULY 1952 No 1721

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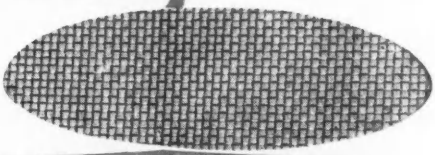

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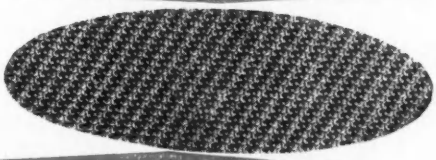

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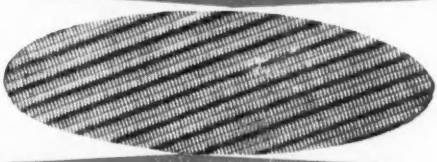

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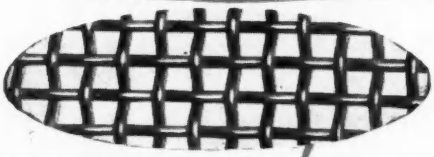

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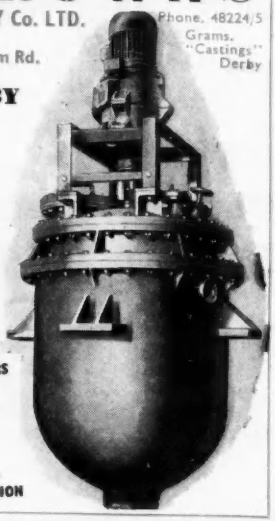

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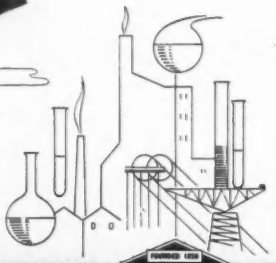

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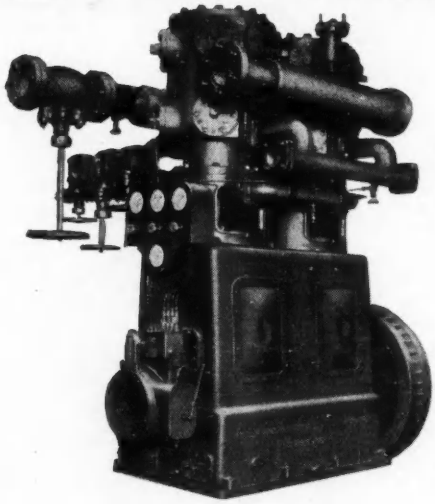

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## INDEX TO ADVERTISERS IN THIS ISSUE


| | Page |
|---|---|
| Baker Perkins, Ltd. | ii |
| Boots Pure Drug Co., Ltd. | 33 |
| Braby, Fredk., & Co., Ltd. | xv |
| British Drug Houses, Ltd. | Cover ii |
| Brotherhood, Peter, Ltd. | i |
| Browns Foundry Co., Ltd. | Cover ii |
| Callow Rock Lime Co., Ltd. (The) | Cover iii |
| Cascelloid, Ltd. | v |
| Chemical Age of India | x |
| Chemical Engineering Wiltons, Ltd. | xvi |
| Cheshire Engineering Co., Ltd. | x |
| Classified Advertisements | 36, xiii, xiv |
| Danks of Netherton, Ltd | vi |
| Dryden, T., Ltd. | 16 |
| Elcontrol, Ltd. | xiv |
| Farnell Carbons, Ltd. | 16 |
| Frischer, W. F. | 16 |
| Greening, N., & Sons, Ltd. | Front Cover |
| Guest Industrials, Ltd. | xvi |
| Hess Products, Ltd. | iv |
| Holmes, W C., & Co., Ltd. | Cover ii |
| Imperial Smelting Corporation (Sales), Ltd. | Cover iv |
| Kestner Evaporator & Eng. Co., Ltd. | x |
| Kilner, John, & Sons (1927), Ltd. | 35 |
| Keith, A. Vernon & Co. | x |
| Lennox Foundry Co., Ltd. | Cover iii |
| Mirvale Chemical Co., Ltd. | Cover iii |
| National Enamels, Ltd. | xvi |
| Norton & Riding (Yorkshire), Ltd | 35 |
| Paterson Engineering Co., Ltd. | xii |
| Pott, Cassels & Williamson | viii |
| Powell Duffryn Carbon Products, Ltd. | xi |
| Pulsometer Engineering Co., Ltd. | xii |
| Reads, Ltd. | 31 |
| Robinson, L. & Co. (Gillingham), Ltd., | iii |
| Sandiacre Screw Co., Ltd. (The) | 16 |
| Shell Chemicals, Ltd. | vii |
| Spencer, Chapman & Messel, Ltd. | viii |
| Staveley Iron & Chemical Co., Ltd. (The) | xv |
| Steel, J. M., & Co., Ltd. | 35 |
| Swift & Co., Ltd. | xiv |
| Tyrer, Thos., & Co., Ltd. | ix |
| Wallis, Charles, & Sons (Sacks), Ltd. | 35 |
| Yorkshire Tar Distillers, Ltd. | vi |



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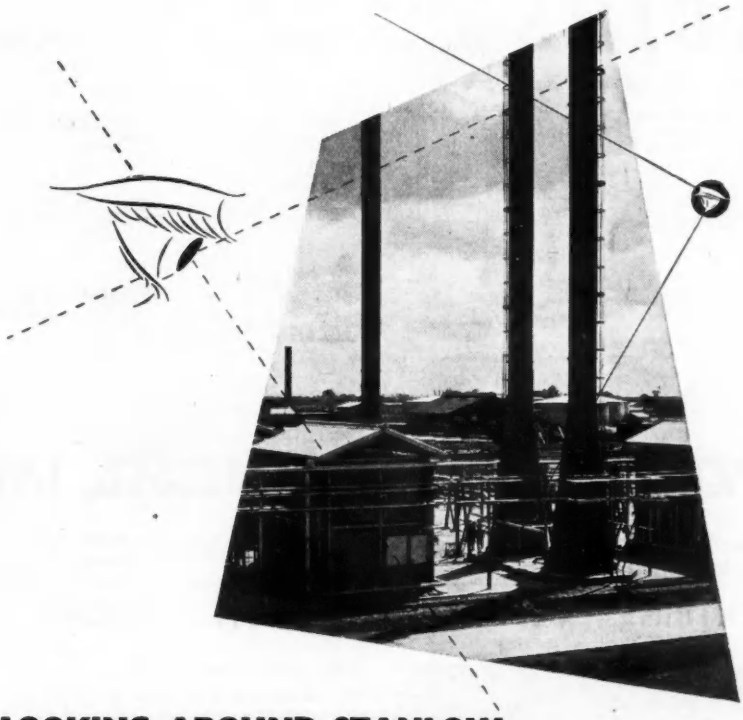

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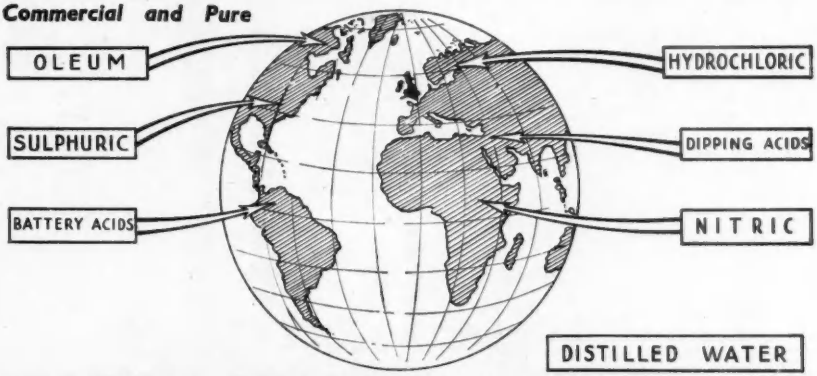


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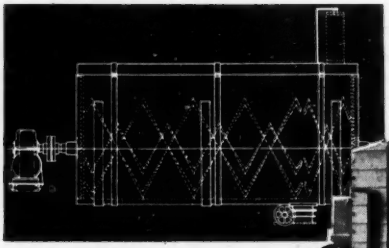

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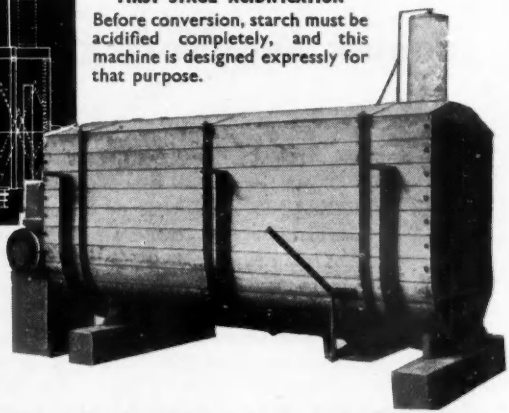

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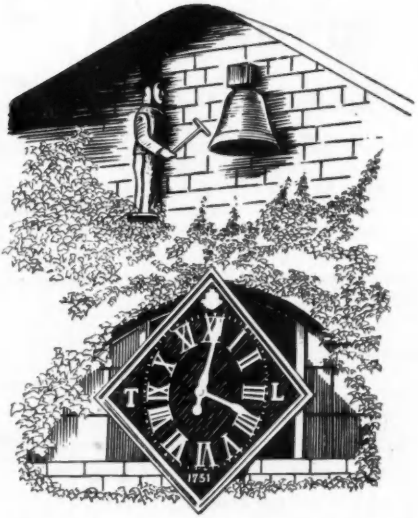


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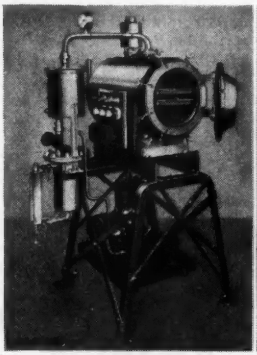

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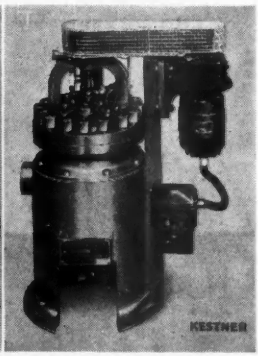


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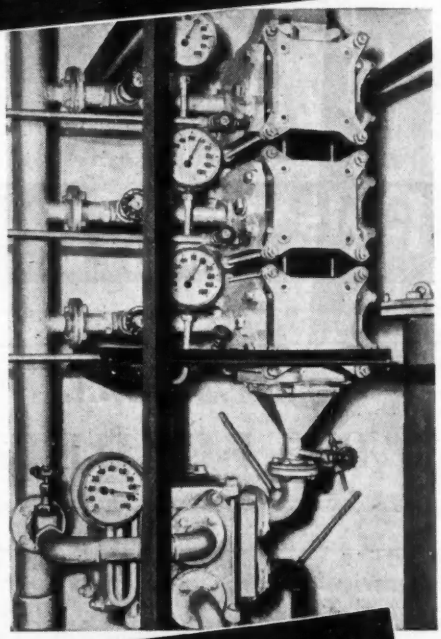

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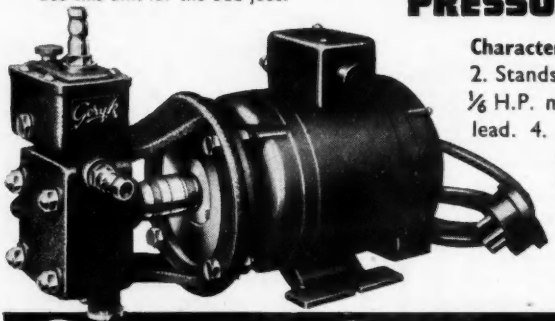


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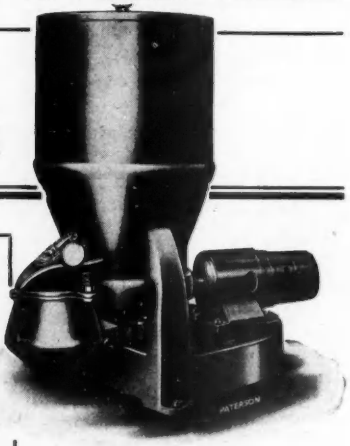


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## *The Fertiliser Future*

'REVOLUTIONARY changes are taking place in the fertiliser industry. In many respects the upheaval is long overdue. From a technological viewpoint the production of fertilisers has not kept pace with other segments of the chemical industry . . . .' These are opening sentences from a recent American article (*Fertilizer Review*, 1952, **27**, 2, 12-15). Gradual evolution rather than drastic change might well be expected in the American industry, so self-sufficient in phosphate rock and potash supplies, so well endowed with synthetic nitrogen facilities, and at least better placed than any other national industry for elemental sulphur requirements. Urgent and large-scale attention to nitrophosphate processes would seem more logical in countries where the pinch of the imported sulphur shoe is felt more painfully. Huge plans to increase fertiliser usage would be more expected to be in countries more dependent than America upon imported foodstuffs for feeding their populations. Now for the thirteenth successive year fertiliser consumption in the United States has increased. But this rate of expansion is not enough to satisfy the U.S. Department of Agriculture. A 5-year plan aiming at almost an 80 per cent increase in fertiliser consumption has been established in the United States. Though it may well be doubted whether these targets can be reached, can we look elsewhere and find intentions that are even hazily comparable?

In some respects the American background differs from that in Western European countries. The population of the United States is steadily increasing; by 1955 there will be 10 million more Americans and by 1960 25 million more. Up to recent times a huge proportion of the arable land in U.S. has been farmed with little or no help from fertilisers. At bitter cost in soil erosion or soil deterioration, America's food self-sufficiency and exportable surpluses have been considerably derived from the natural and consumable fertility of her soils. The point has been reached when maintenance of output, let alone expansion, rests upon fertilisers. But in Western Europe populations are not on the whole expanding; national numbers are far more static. Except in France, the available agricultural acreage per head of population has long ago reached and passed the dangerous point now beginning to be faced in the United States. Of Britain, most vulnerable of all, it can be said that the point was passed in the nineteenth century, but our capacity to exchange so profitably the products of industrialism for the produce from foreign soils has long concealed its

dangers. But we can no longer count upon the ports and their incoming cargoes for balancing the food budget of our 50,000,000 population. World prices for many industrial commodities and products have been dropping recently but food prices have continued to rise. Yet in the agricultural year of 1951-52 that ended on 30 June, there has been a considerable fall in the purchase of fertilisers. Actual consumption by farmers may not have fallen as much as distributed tonnage figures indicate for it is well known that heavy stocks were held on the farms before the D-day of final de-subsidisation. Nevertheless, even making the maximum allowance for this unknown factor, fertiliser usage has receded.

In the United States usage and production have broken records for the thirteenth successive year and a five-year plan visualises an 80 per cent expansion for the future. The Americans will not achieve or approach such increases in plant-food use without making large technological changes in their fertiliser production methods. The acid to process their mineral phosphate must increasingly come from sulphur sources other than the element or from nitric acid made from the air; the manufacture of compound or NPK fertilisers seems likely to be increasingly integrated with nitrogen fixation plants. The successful use of nitric acid as the agent for disrupting the difficult complex of rock phosphate depends not only upon nitric acid production but upon the availability of ammonia or ammonium sulphate to remove or convert hygroscopic by-products. Expansion of phosphatic fertiliser production based upon the familiar sulphuric acid pattern can at best add only about 10 per cent to present output and the addition of only a few large wet-process, sulphuric acid plant centres would double the former usage of the acid; whereas setting up large integrated plant centres, with nitrogen fixation or ammonia recovery in harness with phosphatic and compound fertiliser production, can hope to double present output without increasing sulphur demand.

This is not to say that technological projects for conditions and economics in one country will also suit those of another. But our own soil/population problem is far more serious now than that of America in even twenty-five years' time; our need to produce more food at home becomes increasingly imperative every month. There is, however, no sign that we have comparable plans to increase our use of fertilisers: our return to subsidy schemes to encourage their purchase is in the right direction, but it may at best do no more than bring back the usage rate of 1949/50. Nor is there, and perhaps in consequence, any sense of technological change nor any burgeoning of large projects on a new pattern. It is surely high time that more vigour was introduced to our official fertiliser policy even if the risk is run that demand is stimulated beyond productive capacity. Indeed, the difficulties of such a situation would provide the best possible stimulus for the industry's technology.

# On Other Pages


*Chloromycetin Manufacture* . . 4
*New Papermaking Chemicals Plant* . . 5
*Indian Chemical Research* . . 9
*Xylonite Production* . . 11
*In the Editor's Post* . . 12
*Deposition of Conducting Films on Glass* . . 13
*Metallurgical Section:*
*Increasing Uses of Aluminium* . . 17
*Manufacture of Sponge Iron in Sweden* . . 19
*The Plating of Aluminium Articles* . . 23
*Home News Items* . . 28
*Overseas News Items* . . 29
*Publications and Announcements* . . 30
*Personal* . . 32
*Law and Company News* . . 34
*Market Reports* . . 34


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# Notes & Comments

## More Frasch Sulphur?

THE basic cause of the sulphur shortage is the limitation of the low-cost Frasch process. Any modification that will enable this process to be more widely applied can help the immediate outlook and defer the day when the world's Frasch-mineable sulphur is exhausted. It is sometimes supposed that there is a shortage of salt-domes in America's Gulf Coast region but this is far from the truth. There are plenty of domes, but only a small number of them can be mined. The Freeport Sulphur Company is to open up one of these previously unmineable domes, a deposit at Bay Ste. Elaine, lying below coastal marshland and over 30 miles from any source of fresh water. The principles of the Frasch process will be applied; the operative details will differ. The surrounding sea-water will be used. A barge-like superstructure will carry the plant and about 2,000,000 gallons of superheated sea-water will be pumped into the salt-dome every day—this, of course, as in the normal Frasch process, will melt the elemental sulphur. The water will be heated under pressure to about 100° F. above boiling-point. Special control measures, however, will be introduced so that (1) the scale-forming bicarbonates are not decomposed, and (2) the corrosion-inducing oxygen is almost completely removed from solution in the sea-water. It is expected that these treatments of the sea-water will enable the Frasch process to work without a supply of fresh water, previously considered essential because of the corrosion and scale deposition hazards.

## Chemicals v. Colorado Beetles

KEEPING the Colorado beetle out of Britain is no minor task, for the Channel is narrow and this serious pest of the potato crop is long established in Continental Europe. The vital necessity of reporting any sign of one of these beetles is well publicised and rural vigilance has undoubtedly played an important part in the struggle since the war. In recent years it has certainly seemed that the Colorado beetle has been increasing its efforts to invade England. Thus, in 1950 170 single beetles were found and, far more seriously, 29 breeding colonies of beetles. In 1951, however, only eight breeding colonies were found, though to some extent this reduction may be due to a lessened number of beetles on the Continent rather than to our own defensive measures.

## DDT Principal Weapon

ALTHOUGH most people are aware that a suspect beetle must be speedily reported to the police, few realise what the Ministry of Agriculture's anti-beetle measures actually comprise. An excellent article by I. Thomas and P. Aitkenhead in the June issue of *Agriculture* (1952, **59**, 3, 129-133) shows that DDT is now the principal weapon. Certain susceptible potato-growing areas are regularly sprayed or dusted with DDT; for this task Messrs. Plant Protection, Ltd. act as the Ministry's agents in the principal 'belt' of Kent, Surrey, and parts of the other home counties, while farther North in the King's Lynn port area Messrs. Pest Control, Ltd. last year introduced helicopter spraying. In addition, DDT spraying and dusting is urgently brought into action when an occurrence or incident is reported and confirmed; frequently the place where a beetle or colony is found is not within the routine-treated area, and this is to be expected since the regular DDT treatment should prevent beetle establishment. Soil injection with carbon disulphide is usually carried out at sites where colonies have been spotted or suspected. In 1951, 22,450 acres were sprayed and 4,590 acres dusted in the so-called protected areas. For spraying a 25 per cent DDT emulsion base is used; as a dust a 5 per cent DDT formulation is applied. It is clear that a well organised defence plan, together with DDT and our agricultural chemical industry's service, has so far kept one of Europe's worst crop pests at bay.

# Chloromycetin Manufacture

## Wide Range of Plant Necessary

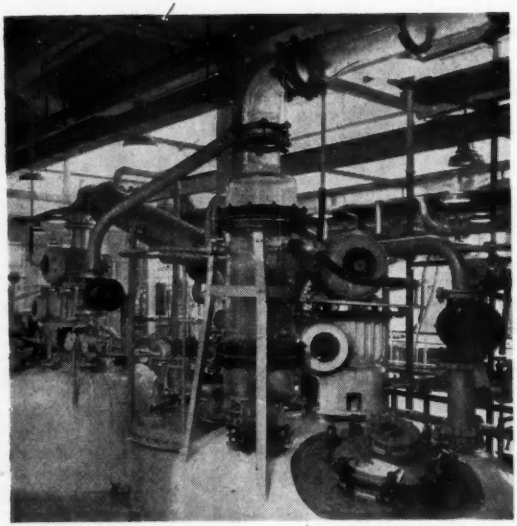
BECAUSE of the complex nature of the chemical processes involved in the production of chloromycetin, a wide range of plant was needed for the new unit installed at the Hounslow factory of Parke-Davis & Co.

The result is indeed a triumph of co-ordination between Parke-Davis, which supplied most of the specifications, and the engineers of the Balfour Group, of which all three companies were involved in their own specialised field.

There are three main stages of the process. The first three steps of the first stage use Pfaudler glass-lined jacketed reaction vessels supplied by Enamelled Metal Products Corporation (1933), Ltd. These vessels are arranged to give maximum accessibility to charge-hole cocks, valves, agitators and controls. Pfaudler-Balfour jacketed stainless steel units and Pfaudler glass-lined refluxing units are employed in the second stage.

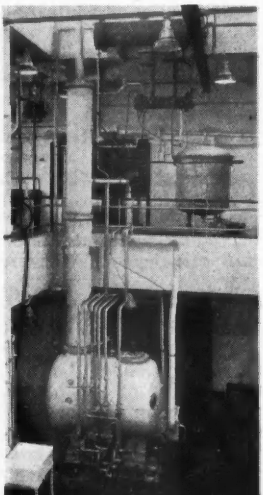
To handle the several drying operations a battery of five Scott vacuum shelf dryers has been installed. All are equipped with automatic safety devices to avoid contamination or overheating of materials. Other Scott plant includes a solvent recovery unit comprising a batch distillation plant with copper fractionating column, the whole unit being manually controlled from one central operating panel.

In addition, a number of Pfaudler-Balfour stainless steel condensers and Pfaudler glass-enamelled connecting pipes and fittings were supplied.



*Above: Glass-Lined Stainless Steel Vessels used in Acid Hydrolysis stages in the Manufacture of Chloromycetin*

*Below: Still and Fractionating Column for Recovery of Solvents*



# New Papermaking Chemicals Plant

## Hercules Powder Company Holds Official Opening

A LARGE party of customers and friends were treated to a most enjoyable outing when a new plant at Erith, Kent, was officially opened by the Hercules Powder Company Limited on Wednesday, 25 June. Special rail coaches carried the visitors from London down to Erith shortly after lunch and following the opening and an inspection of the factory they returned by river boat to the Savoy Hotel where a dinner was held.

The new plant, which will replace manufacturing operations formerly carried on by the firm at Cory's Wharf, brings to the British papermaking industry a readily available range of papermaking chemicals, in wider variety than the company has previously been able to offer. Besides a full range of paste sizes, including high free-resin size not formerly available, Hercules now has facilities for production of fortified paste size, wax emulsions, Vinsol emulsions and defoamers.

The new plant, which is of the most modern design, is situated on a ten-acre plot in the northwest section of Erith, New Bridge and Church Manor Way. Located on the Southern Railway, the plant is well placed to permit shipments by rail or road tank vehicles or in drums and to serve as an export as well as a domestic shipping point. Paste sizes are being manufactured by a continuous process. This process improvement, coupled with the laboratory facilities provided, is said to promise superior service to the individual needs of British papermakers.

### The Opening Ceremony

Guests were welcomed to the new plant by Mr. C. H. B. Rutteman, managing director of the British company. He particularly welcomed colleagues from the United States and Holland and Mr. Palmer from Sweden and their many friends from the papermaking industry. He then introduced Mr. R. Rockwell, general manager of the paper makers' department of the Hercules Powder Company, Wilmington, Delaware, U.S.A., who performed the opening ceremony.

Mr. Rockwell referred to the long and happy history of customer relationships which had existed for 27 years and arose out of the Cory's Wharf production. He explained the company's wide interests in the chemical field and mentioned the American company's tremendous research facilities. At their laboratories in the United States nearly 800 people were doing research work on chemical problems and many were investigating papermaking. The American concern, he said, was genuinely interested in commercial developments in Great Britain and desired to make available here an improved and wider range of products than was possible from the Cory's Wharf plant. In the U.S. his company provided 60 per cent of the resin size for papermaking and in Canada the Canadian company supplied 90 per cent of that industry's needs. He praised British personnel and the various contractors for their achievements.

### A British Plant

'This is a British plant, dedicated to the British paper industry,' he said. 'I trust that the plant will eventually outgrow these premises owing to the service it will render.' He then cut a ribbon to permit visitors to enter the plant, following which employees took groups of visitors around and explained the process and described the equipment.

At approximately 4.30 the party, which numbered about 120, boarded motor coaches and proceeded to the British Oil and Cake Mills' pier where a river boat was boarded. Tea was served on board and later cocktails while points of interest along the Thames were described over a public address system.

At the Savoy Hotel guests were officially received by Messrs. Rutteman, Rockwell, B. L. Morgan, works manager, and A. B. Nixon, vice-president of the parent company.

Mr. Paul C. Hutton, Acting Commercial Attaché United States Embassy, proposed the toast of The Hercules Powder Company. He referred to the size of the company and its widespread activities and then briefly discussed the need for good Anglo-American commercial relations. He expressed the hope that Great Britain would soon solve her dollar difficulties so that the last obstacles to complete commercial freedom between

the two countries could be accomplished.

Mr. Nixon responded and thanked Mr. Hutton for the things he had said about his company. He had, he said, been charged by the president and board of directors, to convey warmest greetings to the assembly and to congratulate those responsible for the completion of a good job of work. He expressed admiration at the beauty and efficiency of the new plant and referred to the board's pleasure at seeing the speedy expansion of the company's interests outside the United States. He made special reference to the happy co-operation between American and British engineers in planning and constructing the plant. The firm had established a highly specialised, fully confidential technical service and this had proved very successful in both Canada and the United States and it was hoped that a similar degree of service and co-operation would soon be established in Great Britain. After expressing his pleasure at seeing so many important Hercules customers present he expressed the hope that another such function might be held in years to come with the only difference that the number of customers would be even greater.

**Gratitude Expressed**

Mr. Rutteman proposed the toast 'The New Plant', first welcoming all the guests with special reference to their non-commercial friends. The company was grateful to the Board of Trade, the county and local planning authorities and to the local council for the ready co-operation they had given in building the new plant. They were especially grateful to Doulton & Co., Ltd., the original owners of the site, for they had recognised the urgency of Hercules' need and had moved heaven and earth to expedite the transaction. Mr. Rutteman referred to the many years of service and co-operation which could be claimed by many of those now at the new plant, and particularly to Mr. B. L. Morgan, who had managed operations for so many years.

In reply, Mr. Morgan described the growth and stature of the paper industry in Great Britain, pointing out that there were still British papers which the Americans could not match. There had been, he said, many problems involved in shutting down the old plant and starting up the new without interruption of supplies to customers. This task had been made possible through the co-operation of their many friends in the paper industry and he was grateful to all those customers who had accepted increased deliveries prior to the shut down so as to reduce demand until the new plant was in operation. After praising various employees and the management he expressed appreciation to the American side for their commercial, technical and personal help. There was a wonderful fellowship on the other side of the Atlantic and there was a very happy relationship between operatives and management which he would like to see over here. Finally, Mr. Morgan said that all Erith personnel were determined to give service in the future fully commensurate with the high quality of the plant and the high standards of the company.

## *Fertiliser Imports*

ARRANGEMENTS have now been made for licensing the private import of those fertilisers and fertiliser raw materials (mainly phosphate rock, potash salts, superphosphate and basic slag) which, as recently announced by the Ministry of Materials, ceased to be imported on public account on 30 June.

Licences issued will be valid for the import of goods originating in and consigned from any country or territory other than Canada, the United States and other American Account countries.

Importers of basic slag will be expected to take two tons of slag already purchased on Government account for every ton for which they are given import licences.

Licences will normally be valid for six months. Importers will be asked to submit periodical returns showing the quantities for which they hold licences and the amount actually imported against those licences.

**Biological Effluent Purification**

An official inspection of the effluent purification plant at their Ruabon factory was held by Monsanto Chemicals, Ltd., on Friday, 27 June. Some £600,000 has been spent on research, development and engineering in building the plant and it has aroused great interest in the chemical and other industries. As a matter of fact the bacterial destruction of organic wastes in percolating filters has never before been used in the chemical industry. A full report of the inspection and of the plant will appear in a forthcoming issue of THE CHEMICAL AGE.

# Water Purification

## Versatile Character of the Electrolytic Method

THE electrolytic process of sterilising water supplies, industrial effluents and other liquids has many advantages, and for certain conditions is preferable to commercially prepared hypochlorites and other forms of chlorination.

Interesting in this connection is the 'Clorocel' equipment of the Paterson Engineering Co., Ltd., of Windsor House, London, W.C.2, which treats water by the addition of electrolytic sodium hypochlorite (E.S.H.). The basic feature is an electrolytic cell, which, by means of a relatively small amount of electric power, converts a weak solution of common salt into E.S.H., all the products of electrolysis being available for use in the sterilising process. Nascent oxygen is formed together with the main product, chlorine, and the presence of oxygen as well as chlorine is an important factor in eliminating taste and smell, which can be done even when using high chlorine concentrations in difficult waters.

The range of application of this method is extremely wide and a number of models are available for industries using water for processing or washing, including breweries, dairies, and food factories. The method is particularly valuable for inhibiting organic growths in pasteurisers and other plant, not only in the plant itself but also in the disposal system, often the source of troublesome problems.

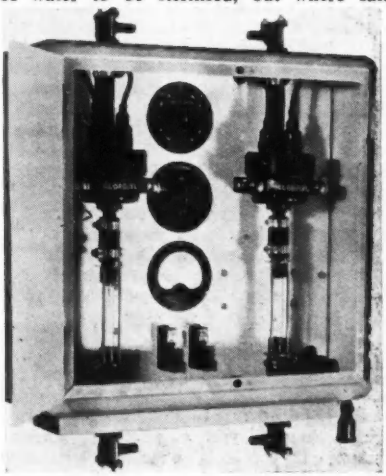
### Swimming Pool Treatment

Another interesting application is for the purification of both fresh and salt water swimming pools. No highly corrosive fluids or gases are used and no high tension current is employed, so both chemical and electrical safety are assured, even when unskilled labour has to be employed. On the same lines it is ideal for small towns' water supplies, and particularly suitable for drinking water suspected of pollution where ordinary chlorination is found to cause taste troubles.

The current for operating the equipment may be taken from any standard mains supply, no external electrical plant being required. The sterilising action is immediate, and automatic control is easily arranged, so that when a tap is turned on anywhere in the water system, the equipment automatically comes into operation. All that is necessary is to keep the salt container topped up from time to time and occasionally clean it out.

Another great advantage of this equipment is that there are no moving parts. Noise and wear are thereby eliminated. Also, the equipment is self-contained, and, for example, may be coupled up to any A.C. mains supply within a few minutes. The only parts likely to need renewal are the special electrodes in the Clorocel itself, although this is not necessary until after some thousands of hours' service, when replacement electrodes can be quickly and easily fitted by non-technical users.

Water purification equipment of this type is available in sizes suitable for dealing with almost every variety of water. Standard plants will handle from 50-50,000 gallons per hour, and above this output plants can be built up into a series of units. The most general form is that in which the E.S.H. flows directly from the cell into the stream of water to be sterilised, but where salt



*The 'Clorocel' equipment*

supplies are difficult the equipment can be assembled in a form in which a much larger concentration of chlorine can be built up from the original supply of salt.

In connection with the salt, the only precautions that need be taken are to ensure that the right grade is obtained, and also that suitable storage is available. Common salt, as sold in bulk, often has a large proportion of foreign matter, which, if allowed to pass through the equipment, will shorten the life of the electrodes. In order to ensure ease of operation and a clean supply, two standard methods are available of producing the correct solution. The first is a straining bag, suitable for small installations, and especially when treatment is intermittent. The bag contains specially graded salt, ready to drop into the salt solution tank, and the bag itself acts as a filter, the preparation of a clean solution taking only a few minutes. For installations required to run for long periods a salt saturator is used, consisting of a closed vessel working under mains water pressure. Here again operation is extremely simple, and the strength of the solution can be varied according to specific requirements.

### Permanent Feature

During the recent European Congress for Chemical Engineering in Frankfurt-am-Main, the Council of DECHEMA, which represents 17 countries, decided to make the congress a permanent annual feature. At the council's meeting on 20 May it was decided to elect a standing committee of four members consisting of Dr. Francis A. Freeth, O.B.E., D.Sc., F.R.S. (United Kingdom); M. Jean Gérard, Vice-President, Société de Chimie Industrielle (France); Dr. Luigi Morandi, President (Italy); and Dr. Herbert Bretschneider, Senator e.h., Vice-President of the Dechema (Germany).

The next European congress will take place in the month of June, 1953, in Paris.

### Tennis Tournament

A tennis tournament and dance will be held on Saturday, 26 July, at the sports ground, University of London, King's College, Lavender Avenue, Mitcham, Surrey. Arranged by the Social Activities Sub-Committee of the Royal Institute of Chemistry, it is open to all Registered Students, Associates, Fellows and their friends.

## *U.S. Graduates in Demand*

### Employment Prospects Best Ever

THE outlook for jobs for American university graduates in chemistry and chemical engineering over the next five to ten years is the best it has ever been, Charles S. Munson, chairman of the board of the Manufacturing Chemists' Association, Inc., said recently in a statement directed at high school graduates.

The chemical industry had been unable to get anywhere near as many graduates in science and engineering as it would like to have this year, Mr. Munson said, and all indications were that the demand for qualified chemists and chemical engineers would remain high for years to come. He urged good students who were interested in science to carry their education as far as they could —through college into graduate work if possible.

The chemical industry employed about 100,000 chemists, 30,000 chemical engineers and 17,000 physicists, and this existing manpower pool was not being replenished fast enough. Some 10,600 Bachelor of Science degrees in chemistry were awarded in 1950, but the number had been falling off since then. Preliminary estimates indicated that some 6,800 students would graduate this year, and only about 5,600 in 1953.

### Shortage of Chemical Engineers

The need for chemical engineers alone, according to Mr. Munson, was indicated by the fact that the chemical industry could have used 5,000 of them last June, but only 3,800 graduated.

This growing shortage came at a time when the chemical industry was expanding rapidly, Mr. Munson pointed out. A relatively young industry, chemicals had grown at an average rate of 10 per cent a year over the last quarter century, while the annual growth for all industry averaged only 3 per cent. Production of industrial chemicals was five and a half times what it was in the 1935-39 period, and the industry would spend more than $6,000,000,000 on new expansion from the outbreak of the Korean War through 1955.

Graduates with Bachelors and Masters of Science degrees were receiving starting salaries of $350 to $400 a month while holders of Ph.D. degrees were beginning as high as $500.

# Indian Chemical Research

## The Work of the National Chemical Laboratory

INDIAN chemical progress has been very rapid during the last few years, and the achievements to date of the National Chemical Laboratories in the country are described in a recent issue of *Indian Trade and Industry*. This chain of eleven National Laboratories, seven of which are already functioning, stretches from Mysore to New Delhi and from Calcutta to Poona. Some of the investigations conducted have already yielded results of significant interest, and are gearing science to the solution of India's many problems. Large quantities of indigenous materials previously thrown away as waste are now being saved as a direct result of this research.

Broadly speaking, the N.C.L. is split up into seven major divisions: biochemistry, organic chemistry, inorganic chemistry, high polymers, chemical engineering, physical chemistry, and survey and information.

The Engineering Division is equipped with machinery for various chemical processes—crushers, grinders, distillation apparatus, vacuum- and steam-jacketed pans, etc. Here, experiments are in progress on the production of certain phosphatic fertilisers not yet manufactured in India. Phosphate from Trichinopoly in Southern India is the basic material for this process, and a plant is being erected for the production of triple superphosphate. The experiments aim at determining the best conditions for commercial manufacture. The preparation of ammonium sulphate from magnesium sulphate is also being studied.

### Tobacco Waste Used

Another important project for which fairly elaborate apparatus has been set up is the extraction of nicotine sulphate from the 100,000,000 lb. of tobacco waste produced by the annual Indian tobacco crop of 684,000,000 lb. Some of this scrap is used for snuff, but the vast majority is wasted.

Another plant being set up is for the preparation of cellulose pulp from indigenous bamboo, reeds, grasses and other varieties of wood. The ultimate object of this is to use the pulp in the manufacture of rayon, plastics, certain types of paper, and photographic film.

Alcohol is being employed as the starting point of a basic organic chemicals industry. First it is used to produce ethylene, and then glycol, styrene and other chemicals, hardly any of which are produced in India at present, in spite of the fact that the country has large quantities of cheap alcohol, 20,000,000 gallons being produced annually as a by-product of the sugar industry.

### A Cottage Industry

A process that bids fair to becoming the basis of a cottage industry in India is the aqueous extraction of castor seeds. These seeds are roasted and ground to a meal, which is then boiled in water with the addition of small quantities of salt, lime and potassium nitrate. Castor, one of the best-known lubricants apart from its medicinal value, is released and removed, and the yield of oil obtained is about 90 per cent of that originally in the seeds.

A recent achievement of the Biochemistry Division is the production of citric acid—used largely in pharmaceutical preparations, food industries, ink manufacture, and dyeing and calico printing—and of calcium gluconate, by the fermenting action of fungi on sugarcane and glucose. Developed in the laboratory with a view to commercial exploitation, the process has been made over to a Bombay firm which is being advised in the setting up of a bench pilot plant. Citric acid is now being imported from the U.S.A.

Another promising line relates to the production of sulphur—in short supply in most countries—by micro organisms. 'Digested' sewage, as produced in the sewage purification works at Dadar, is used here.

Sugar is not generally associated with boot polish, but the Organic Chemistry Division, in which no less than 30 projects are in hand, sees a very definite connection between the two. A by-product of the sugar industry is a black, solid sticky 'wax,' not of much use in its original state because it does not possess properties of solvent-retention and take-up. The process evolved at the N.C.L. is for bleaching the wax and chemically modifying it. This modified wax approaches in chemical properties carnauba wax, which

is imported and for which no substitute has so far been found in India.

Tobacco seed is another by-product which has been more or less neglected so far, so much so that a couple of years ago tobacco seed oil, which is used industrially in foreign countries and considered edible in some, could not be obtained in India. A process for treating this oil for use in paint and varnish manufacture has now been patented and is available for commercial adoption by industry.

### 'Wrinkle' Finishes Patented

By a process of which the Laboratory is justly proud and which it has had patented in India, the U.K. and the U.S.A., oil from Kamla seeds is used in the preparation of varnishes and paints which, on drying in air at ordinary temperature, yield artistic 'wrinkle' finishes, hitherto obtainable only by baking films of alkaline varnishes. This method results in beautiful decorative finishes—but not without a utilitarian value—on materials that cannot ordinarily be subject to baking.

It takes only two or three minutes after the Kamla oil has been spread on the glass, wood, metal or other surface for the film—subjected to air-drying—to set into wrinkles of various patterns and the required colour. Wrinkle finishes give better grip than plain finishes, besides rendering the material scratch-proof.

In the Plastics and Polymers Division, methods of making resins by the exchange of ions are in progress, use being made of such indigenous raw materials as coal, cashew-nut shell liquid, sulphuric acid, agricultural waste and naphthalene. The resultant resins can be used in the treatment of brackish waters, to make sea water potable and to remove fluorides from water found in certain parts of the South, making it drinkable: Medicinal types include the treatment of dropsy and a certain type of ulcer. Ion exchange also results in the recovery of sugar from fruit wastes and in the preparation of soft-curd milk for children.

In another experiment in this section use is made of Indian asbestos in the manufacture of battery containers, which have to be acid-proof. An essential of the process, which aims at the curtailment of imports of battery containers, is the mixing of bitumen with the asbestos and other fillers. These experiments followed a reference by the Tariff Board to the N.C.L. in view of the restrictions placed on imports of Canadian and South African asbestos.

The common cashew-nut of which India is a big producer, yields from its shell a dark liquid which when applied to a tin or iron surface and baked at about 120° C., produces a shining film, resistant to water and ordinary organic solvents. An important investigation, it has as its objective the use of this composition for the lining of food and oil containers.

Another set of experiments in the Organic Chemistry Section relates to the purification and removal of objectionable odours from neem oil, rendering it suitable for use in high-grade soaps, and even for edible purposes. The purified oil yields, on hydrogenation, qood quality stearine. It can also be used in the preparation of Vanaspati. Thus neem may replace groundnut oil to a substantial extent in the manufacture of soaps and other industrial products.

Other subjects under study range from fountain-pen ink to soya bean plastics and soya bean milk; from a cheap process for the manufacture of slates and lead pencils to experiments on dyes and camphor-making and the preparation of solid disinfectants. The use of gypsum powder in white paints, the preparation of silicon tetra-chloride, not to mention the utilisation of nitre cake and the treatment of effluent water are but a few of the many problems being tackled.

### Liaison Essential

For research to play the important rôle allotted to it in national development, it is necessary that the results of laboratory investigations should be quickly and effectively translated into actual production. This is a subject that is naturally receiving much attention, and proposals for the establishment of a National Research Development Corporation of India on the lines of similar specialised organisations in the U.K. and Canada are now under the consideration of Government. A primary function of this Corporation would be to demonstrate how processes can be operated on full production basis. The early establishment of the Corporation should go a long way towards avoiding the risk that valuable research may be left high and dry in the laboratories.

# Xylonite Production in Britain

## Progress & Development in 75 Years

MANY entertaining personal anecdotes and sidelights on the origin and early struggles of the British Xylonite Co., Ltd. (now the Xylonite Group), are revealed in extracts from the private journal of C. P. Merriam, son of the founder, given in an illustrated booklet published by the company to mark its 75th anniversary on 13 June, 1952.

The long journey from 122 High Street, Homerton, where the first factory was started, to the beautiful old house built by James Wyatt (1746-1813), which is now the London office and showrooms of the company, has been fraught with adversities from the serious fire at Homerton in 1885 to the destruction of the 'Plastics Centre' showroom in Chiswell Street, E.C., by enemy action in 1940.

Once again it is a story of the triumph of private enterprise and the faith and determination of the founder. Some idea of the achievement is shown by the fact that in 1877 the company had 29 employees, whereas at the beginning of this year 6,300 persons were employed by the group.

### Seven Companies Comprise Group

During the past 15 years new companies have been formed and others acquired, fresh factories established, and new techniques and materials developed. The group, which now comprises seven companies, has taken a prominent part in the general expansion of plastics since the war, and has formed links with The Distillers Company. Ltd., and Ilford, Ltd.

When the company's sole product was Xylonite it was possible for one or two chemists, with a small staff of unqualified assistants, to exercise chemical control of routine operations and still find time to work on improvements and the investigation of customers' difficulties.

The decision to make synthetic camphor, taken after the First World War, was forced on the company by the high prices which had to be paid for Formosan camphor when competing supplies of German synthetic camphor were cut off, and necessitated an immediate increase in the scientific staff. The first camphor factory came into operation in 1927, but the search for improvements in the process has been continuous, and has kept a number of chemists and physicists occupied.

### Separate Research Station

At Brantham, development work on film manufacture and on cellulose acetate, ethyl cellulose, polystyrene, polyethylene—each of which has its own problems of technique—required in the period between the two wars a steady increase in scientific personnel, and it was felt that a separate research and development station outside the factory was needed, where men could work without the distraction of day-to-day manufacturing problems.

A property known as Lawford Place, two miles from Brantham, was bought in 1945 for conversion into a research centre for BX Plastics. A plastics development laboratory equipped with small-scale plant, and a laboratory for experimental chemical manufacture have already been built. The other laboratories are at present housed in temporary quarters.

Brantham, Larkswood, and Dundee, the raw material works, maintain their own development laboratories for the investigation of immediate factory problems. The development laboratory at Dundee works is under the general direction of Lawford Place. Halex and Cascelloid both have development departments dealing with fabrication. Cascelloid's excellent new development laboratory was opened in 1950.

The Expanded Rubber Company has its own development staff who are in regular consultation with Lawford Place on problems involving plastics.

Research and development staffs of the group now number over 200, of whom about 60 are qualified chemists, physicists, or engineers.

It is interesting to note that the manufacture of imitation coral jewellery with which the business was begun and proved to be 'an absolute frost', is now being successfully carried on at Christchurch, near Bournemouth, by Scintillex, Ltd., a wholly-owned subsidiary formed in 1947.

In spite of the larger number of factories

and the consequently greater difficulty of keeping in touch with all grades of employees, the importance of the human side is fully appreciated and one section of the booklet deals with the personal relationships in the group and the amenities available.

## IN THE EDITOR'S POST

### *Electron Micrographs*

SIR,—We have seen, in your issue of 14 June, 1952, the letter from Associate Professor George W. Cochran of the Utah State Agricultural College, in which reference is made to our comments in *The British Journal of Photography* for 4 April, 1952. We have re-read our comments and do not find that they require any amendment in the light of Professor Cochran's remarks. In refuting our challenge of the novelty of Mr. Bensley's process, Professor Cochran totally ignores all references made by us to the researches of workers other than Carey Lea, confining his attack to our mention of allotropic forms of silver, which is only one of the phenomena involved. We cannot see that there is any novelty in producing a certain amount of silver chloride in a gelatine film, exposing it to light, and then developing in a physical developer. The product of such a procedure presents no novel feature.

We think we made it clear that our main objection was to the use of the term 'electron micrographs in colour'. After stating clearly that had the title of the American paper been 'Coloured electron micrographs' no one could have objected, we went on to state what it was that Mr. Bensley claimed to have discovered, and also what Professor Cochran and his co-workers had done. Now, Professor Cochran describes his results as 'my coloured electron micrographs', and you, Sir, in your note, use the same expression! We have already said that no one can object to such a description. We still disagree with 'Electron micrographs in colour'; we still claim that it is a misleading description; and we still fail to recognise that Mr. Bensley made an 'amazing discovery', while the practical utility of such a fortuitous colour distribution in a scientific record is to our mind more than dubious.—Yours faithfully,

ARTHUR J. DALLADAY
Editor, British Journal of Photography.

*Editor's note: Professor Cochran confined his attack to Carey Lea's allotropic forms of silver and (not mentioned above) his red and purple silver chlorides, for the good reason that they were the salient points made by the Editor of the 'British Journal of Photography' in his editorial. The fact that these were made at all indicates that Mr. Bensley's process was basically misunderstood from the first in Mr. Dalladay's critical comments. While we admit that 'coloured electron micrographs' might be preferable to 'electron micrographs in colour' we do not believe that strong exception can be taken to either. Professor Cochran made it quite clear in his paper* (CHEMICAL AGE, 66, 401-2) *that an electron beam contained no colour and he explained his process fully. Even more important, we dispute Mr. Dalladay's suggestion that these micrographs are of dubious practical utility. They undoubtedly show up some effects which would not be apparent by the usual methods.*

### *Annual Conversazione*

THE London branch of the Science Technologists Association will hold its annual conversazione in the chemistry department, King's College, Strand, London, at 6.30 p.m. on Friday, 11 July. The opening address will be given by Professor D. H. Hey. Demonstrations will be presented by the British Post-Graduate Medical School, London School of Hygiene and Tropical Medicine, National Institute for Medical Research, Regent Street Polytechnic, British School of Pharmacy, City of London School, St. Mary's Hospital Medical School, Queen Mary College, Royal Free Hospital Medical School, St. Thomas's Hospital Medical School and King's College. The subjects include an electro-magnetic counter, a method for the estimation of Vitamin $B_{12}$ in serum and urine, thermoelectric measurement of humidity, electrical conduction in glass at high temperature, and filtration apparatus for the determination of sulphates in urine and petrological micro-techniques.

# Deposition of Conducting Films on Glass

IN BOTH Britain and the United States, research workers approaching the problem from entirely different directions have developed processes for depositing improved electrically conducting films on glass, the one important application of this being to enable the windows of aircraft to be heated so that there is no danger of the pilot's view being obscured through icing up.

Shortly after the war American workers announced the development of a process whereby ordinary glass could be coated with a very thin film, which besides being transparent was electrically conducting. The process consisted of heating a sheet of glass almost to the softening point and in that condition spraying it with a solution containing chloride of tin. So far as is known, the film left on the glass was plain tin oxide, but in its normal form as a pure white powder, tin (stannic) oxide is not usually regarded as an electrical conductor, and so far the reasons for the conductivity of the film in question appear to be unexplained.

### Points of Difference

For several years the Light Division of the National Physical Laboratory in Britain has also been working on a subject in which transparent conducting films are of importance, namely, the selenium barrier layer photo-cell. In the production of the light-sensitive discs used in photography for exposure meters, a film of some suitable material has to be deposited on the top of a layer of selenium and must be both electrically conducting and not opaque to light. During the course of this work the investigators discovered a method of producing—if necessary on glass—thin films of cadmium oxide. These films resembled the American tin oxide films in two utilitarian respects, namely, that the transmission for white light was about 80 per cent and the electrical resistance was 100 ohms between opposite sides of a square. The chief points of difference were that the cadmium oxide film was slightly tinged with yellow and that it was much softer mechanically and more liable to chemical attack. The American film was mechanically very hard and durable and was resistant to most chemical reagents.

It was a coincidence that the announcement of the American discovery should have come at a time when the National Physical Laboratory was dealing with films which could be used for conducting and heating. The particular cadmium oxide film which had been produced is suitable for covering glass, but must be protected from the elements because it is subject to damage—by fingermarking, for instance. A further drawback is that it can only withstand a temperature of about 60-70° C., whereas the American film can stand several hundred degrees.

### Certain Disadvantages

On the other hand, the American process had certain disadvantages. Not only is there a considerable chance of breakage when the hot glass is being sprayed, but also—as can readily be understood—it is not easy to produce a uniform thickness of film. The difficulties encountered resulted in a high percentage of rejects and the cost of the coated glass was therefore high.

The process used at the NPL is known as cathodic sputtering. A circular disc of the relevant metal is situated inside a vacuum chamber. The air is pumped out and replaced with argon gas at a suitable low pressure, a continuous flow of argon being maintained. A voltage of perhaps 1,000 volts D.C. is then applied between the disc and the chamber, the disc being the negative electrode. Bombardment of the disc by the ionised argon causes the very slow dissolution of the metal disc in a form very similar to vapour. If the article to be coated—such as a sheet of glass—is located in the chamber at a convenient distance from the disc, the vapour will condense on its surface as a metallic film. The rate at which the metal is deposited depends on the current through the discharge. If a suitable trace of oxygen is added to the argon in the chamber, a film of the oxide—not of the metal itself—will be obtained in certain cases, as when cadmium is used for the disc (this particular variation of the

sputtering process is the subject of several industrial patents). The sputtering process has important advantages over the American method, since it is independent of heat and also of chemical reactions with the attendant hydrochloric acid fumes. On the other hand, the cadmium oxide film produced in Britain, having different chemical and mechanical properties from those of the American tin oxide product, is best suited to rather different uses.

### Alternative Process

Films of metallic oxides can also be made by an alternative process which has been described as long ago as 1907. A thin film of the actual metal is deposited either chemically or electrically and is then heated to a temperature slightly below its melting point and held at that temperature for as long as may be required. In the case of quite a number of metals which tarnish readily, the thin metallic film will combine with oxygen from the atmosphere to form a film of the oxide.

Early in 1951 investigators at the NPL started experiments designed to extend the range of oxide films which could be produced by the sputtering process, either directly or by subsequent heating of the sputtered metal film. They succeeded in producing quite a large number of oxides, but with one exception (apart from the cadmium oxide already mentioned) none of them showed good transparency combined with a sufficiently high electrical conductivity to be of practical use. With the aid of the sputtering process and the application of heat, however, a film of tin oxide was produced having the same chemical and mechanical properties as the American product, but thinner and having an electrical resistance considerably higher, being of the order of 2,000-3,000 ohms 'per square.'

A number of experiments were then carried out with the object of lowering the resistance of the tin oxide. This investigation was still in progress when the DSIR was approached by the Ministry of Supply, who were anxious that a suitable alternative to the American product should be produced as rapidly as possible for use on our own aircraft. The Ministry preferred to use a British product and save dollar expenditure, and an electrical resistance lower than that of the American coating was preferred.

A decision had to be made whether to go on endeavouring to produce an improved tin oxide or whether to examine the possibilities of metallic film. Gold films seemed to offer the most promising starting point because gold has a very low electrical resistance and is chemically inert, so that the films it produces are not readily damaged by tarnishing. Calculations based on the properties of solid gold indicated that a film thin enough to transmit 70 or 80 per cent of light should still have an electrical resistance of only a few ohms 'per square'. On the other hand, films of this thickness which had previously been made by other workers had final resistances of the order of 100 ohms 'per square' or even higher. The accepted explanation was that these gold films were not continuous but granular.

Whether the film could be modified to make it more continuous or more regular in structure was, therefore, the next stage. It was found that the result obtained depended to a considerable extent on the manner in which the gold was deposited and also on the state of the surface. The electrical conductivity was even influenced by different methods of cleaning the glass. In no case could values of the required order be obtained, however, and difficulty was also experienced in obtaining consistent results with the same thickness of coating.

Since the equipment available included a small plant capable of producing films of the whole range of oxides, the investigators proceeded to examine the effects of depositing thin layers of gold on a number of these oxides which, of course, had previously been deposited on glass. It was soon found that if the base material was one of certain oxides, such as lead or bismuth oxide, the resistance was much lower than that of any film produced by direct deposition on glass. Moreover, instead of being blue green, the coated glass was of a pale straw colour and was much more transparent.

### Effects Examined

The effects of heating the film deposited on the oxide were then examined. It was found that when the film was held for a few minutes at a temperature of 200°C. its electrical resistance was lowered by a factor of about two, this reduction being permanent. The final result of coating, for example, gold on bismuth oxide would be a resistance 'per square' of 10 ohms and a transmission of white light of just under 75 per cent. That

result is typical of the development work so far carried out on this type of film, though certain minor modifications have been introduced. It has been found, for instance, that because of the softness of the gold it is necessary to protect the film by laminating a cover glass over it. This lamination raises the transmission to over 75 per cent by optical effects.

There is also a possibility that after the gold film has been produced another oxide film could be deposited over it, thus providing a considerable degree of mechanical protection at the expense of a 1 or 2 per cent loss in transmission.

The films associated with the gold process are both about a quarter of a millionth of an inch thick. The thickness of the oxide film is immaterial so long as it is not much less than this, but that of the gold is critical because it influences both the transparency and the electrical resistance. Mr. J. S. Preston, the officer in charge of this investigation, predicts that this type of film, with or without a protective oxide coating, is likely to be generally used, but it is possible that an improvement in transmission might be effected.

By using two oxide films, one above and the other below a metal of suitably controlled thickness, an effect can be obtained which is analogous to 'blooming' a photographic lens, in which case the reflection from the surface is much reduced and the transmission can be increased to slightly over 60 per cent. On the other hand, there would be some loss in electrical conductivity, the resistance going up by about 15 ohms 'per square'.

### Process Advantage

A final comparison of the position in this country and the United States suggests that Britain has the advantage of a process which is capable of quite accurate scientific control. It has not yet been fully tried out on a large scale, but there appears to be no reason why it should not be suitable for commercial production. The sputtering method produces gold films about a quarter of a millionth of an inch thick in about five seconds with a current of 1/10 amp., the diameter of the gold disc being 3½ in. in the experimental plant.

On both sides of the Atlantic the cost of the raw materials is negligible, even that of the gold amounting to only about 1d. per sq. ft. at current prices. The British product has a resistance so much lower than that of the American coating that considerably reduced voltages can be used for heating purposes. In fact, one can almost envisage the heating of a motor car windscreen directly from a 12-volt battery instead of from a separate high voltage generator in the car, which is necessary in the case of the American product. In the aircraft industry, insulation problems should be considerably reduced by the lower voltage, which is now a possibility. The low resistance of the British coating can thus be considered to outweigh its slightly lower transparency.

### Considerable Possibilities

The potential field for electrically conducting films on glass cannot yet be clearly discerned, but it is obvious that considerable possibilities exist. For instance, a quite small-scale problem is encountered with sensitive electrical instruments which are partially covered by a glass window. The glass is liable to become electrified when being cleaned, so that it attracts the pointer and a faulty reading results. This could be avoided if the inner surface of the glass were covered with a film which was sufficiently conducting to allow the electrical charge to be screened.

For this purpose either the cadmium oxide or the tin oxide film produced by the NPL process would be quite suitable, the latter being preferred because of its greater resistance to chemical effects. There are also circumstances in which the cover glass of an instrument tends to mist up. For a small instrument only a small amount of power would be required, so that the resistance of the film could be moderately high without necessitating the use of excessive voltage.

Another possible application, which must be regarded as entirely speculative at this stage, is the production of fixed resistors such as radar components consisting of strips of glass coated with these materials. Fixed resistors with relatively high resistances are usually required here and the oxide films might be suitable for this purpose, if their resistances were stable enough.

Electrically conducting films might also be used for various vacuum devices such as the fluorescent light or the mercury-in-glass rectifier, where it is an advantage to have certain parts of the inner surface of the glass partially conducting.

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# Metallurgical Section

## *Increasing Uses of Aluminium*

### *Research & Development in 1951*

PROGRESS in several important fields of application, some of which hold exceptional promise for successful long-term development, is recorded in the annual report for the year ended 31 December, 1951, of the Aluminium Development Association.

Shortage of aluminium made it particularly difficult to undertake items of a short-term nature, but those requiring long-term investigation had been carried on with considerable success. Towards the middle of the year there were indications that difficulties in the supply of aluminium were likely to be overcome sooner than had been expected.

Research work carried out was in the main divided between sub-committees dealing with welding; large riveted joints; structural problems; corrosion; and finishes.

The Research Committee, which gave general direction to the sub-committees, devoted considerable attention to the fatigue of aluminium alloys, particularly of aluminium structures. Interest was shown in the new fatigue laboratory of the British Welding Research Association and it is expected that work on welded aluminium alloys will be undertaken there.

#### New Alloy Development

It was decided that development of new alloys could best be undertaken by member companies. The effect of composition and treatment on the properties of H.10-type alloys was considered and the resistance of these alloys to corrosion.

Investigation into the forming properties of the H.10 alloys was initiated by the British Non-Ferrous Metals Research Association under a new committee with Dr. N. P. Inglis as chairman.

Information was reported to the committee of tests on solders and soldering methods, including the use of ultrasonic equipment. Other subjects under consideration were the tearability of aluminium and its alloys; recommendations on wash primers; resistance of aluminium to abrasion; and the protection of aluminium alloys by metal-spraying.

The welding research sub-committee was maintained in being although it had not met since the cessation of the researches at the University of Birmingham. The association has entered into closer co-operation with the BWRA, and greater emphasis is being laid on light alloy research in that organisation, the aluminium industry being well represented on the committees.

#### Memorandum Issued

A memorandum on the corrosion-resistance of wrought aluminium-magnesium-silicon alloys was issued during the year for the guidance of member companies in dealing with inquiries. It expressed the considered views of the sub-committee based on all technical data available and further investigations on the problem have since been brought to the attention of the committee. The stress corrosion of alloys of this type, and also of the aluminium-5 per cent magnesium alloys, has been considered.

Corrosion tests on riveted joints were in progress at the end of the year, and consideration has been given to the preparation of a publication on methods of preventing corrosion due to contact with dissimilar metals and other materials. Interim reports were received on investigations on corrosion by contact with cement and plasters; with coal and peat; with artificial fertilisers and other materials.

In addition a programme of tests was started, in collaboration with the Forest Products Research Laboratory, on the behaviour of aluminium alloys in contact with timber.

Following the decision made in 1950 that investigation into possible vitreous enamel finishes for aluminium should not be further pursued at present, a full review of techno-

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logical progress in the art was prepared and published. Enamelling of aluminium is not being further developed in this country or elsewhere at present.

The Research Committee has now approved wider terms of reference that make the finishes sub-committee responsible for following progress and initiating desirable development work on applied finishes in general, including metal-spraying, painting, anodising, plating, and allied processes. Of these, the most interesting at the moment is the new hard surfacing or hard anodising process developed independently in the U.S.A. and in Scotland, and which is now being actively fostered.

**Recommendations Made**

Following complaints about loss of adhesion of wash primer on material treated in works before despatch to the user, particularly the shipyards, a special meeting was called and recommendations for the paint treatment and/or wash priming of plate and large sections were agreed; they have since been issued to members and submitted to the Admiralty.

A number of new organic finishes that might be advantageous on aluminium have been examined.

Extensive amendments were proposed to a draft Code of Practice for the Painting of Non-Ferrous Metals; the collated views of the industry were forwarded to the council for Codes of Practice and substantial amendment was obtained.

In 1950 it was decided to undertake a series of fire tests to determine the degree of protection needed for aluminium structures in order that they should comply with the 1948 International Conference on the Safety of Lives at Sea.

Considerable progress has been made and three major tests completed by the Marine sub-committee at the Fire Research Station, Elstree, in co-operation with official bodies. Although the programme has not yet been entirely carried out, sufficient results have been obtained to make it possible to assess the amount of protection required for aluminium structures in passenger vessels.

Two outbreaks of fire in aluminium buildings were investigated, one in a single storey building belonging to the Ministry of Works and the other in a prefabricated school at Sheffield. Full assistance was given by the authorities concerned and it was accepted that no suggestion that aluminium alloys were to blame could be drawn from the incidents.

Light alloy roof supports, particularly forged aluminium roof bars and props made from extruded sections, are being increasingly used following the development of designs in Germany, and full details of the components used were obtained by the mining equipment sub-committee. In some cases the association has succeeded in arranging for systematic tests to be made on these components. Continental progress with aluminium in this field is considerable and this was studied during a tour of the important establishments in Northern France, Belgium and the Ruhr.

The ban on the use of magnesium in coal mines has led to questions regarding the susceptibility of aluminium alloys to sparking, and the association undertook tests with the Safety in Mines Research Establishment.

Increased scope of the association's educational work in 1951 was well reflected in the inquiries which increased by 40 per cent to 1,113, including a number from overseas. The educational mailing list now includes 1,710 names, an increase of over 500 in the year.

Much of the expansion has been due to the appreciation of individuals and official bodies concerned of the desirability of a central source of information on aluminium in relation to education. There has been an increase in the number of major examinations including aluminium as a subject for study, coupled with an increasingly close relationship between the association and the bodies responsible for examination administration.

**Information Service**

Provision of information continued to absorb an appreciable part of the staff and other resources of the association, and it was evident that the value to the industry of the goodwill which is being built up through the Information Services must now be considerable.

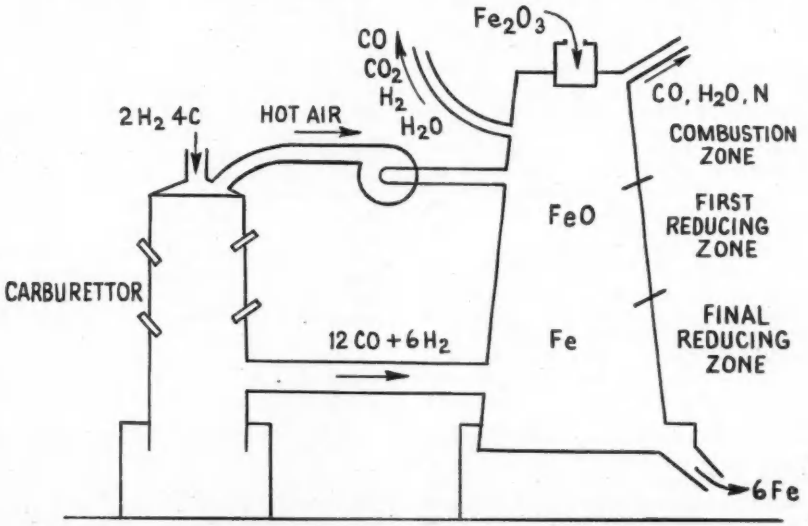
Inquiries have shown a slight decrease over each of the past two or three years, coinciding with the increase in the number of publications available and with their wider distribution. Technical and trade inquiries total almost 3,000 a year, in addition to over 1,000 inquiries directly concerned with education.

# The Manufacture of Sponge Iron in Sweden

SO-CALLED Swedish sponge iron is one of the cheapest sources of material for making iron powder, although it is not generally of the highest grade or purity, or as high as that obtained by, say, hydrogen reduction of precipitated iron oxide. For the most part in the Swedish process, high grade iron ore (over 60 per cent Fe) is reduced with carbon. Formerly wood charcoal was largely used, but anthracite and coke (as in the Wiberg-Söderfors process) are now employed. The ore and carbon are placed in steel or clay saggers and loaded on bogies which are passed through a tunnel kiln. Sometimes limestone is added to absorb the sulphur produced, and excess carbon must also be removed. The ore and reducing agent are normally in alternate layers, and the product is a sintered cake of sponge iron of medium purity.

Several methods are used in Scandinavia, such as the Norsk Staal and the Flodin processes, but probably the most important and most widely used is the method invented by Wiberg many years ago, known as the Wiberg-Söderfors process. Wood charcoal was mainly used as reducing agent at first, but the plant was subsequently adapted for coke when charcoal became too expensive. It is the subject of several Swedish patents, on which the present account is largely based. It has also formed the theme of a special report (by John Stälhed) of the Blast Furnace Committee of the Verein deutscher Eisenhüttenleute; see *Stahl u. Eisen*, 1952, 72 (9) 459-466.

Although between 1935 and 1950 prices both of wood charcoal and of coke rose to five times the earlier price, coke was of course, the cheaper at about 100 Swedish kroner per ton, as compared with 250 kr. for wood charcoal. Total production of iron in Sweden is around 850,000 tons per annum. Owing to the rich nature of the ore in that country and the former abundant supplies of cheap charcoal the manufacture of sponge iron was somewhat favoured. Its manufacture began about 1911, with the introduction of the Höganäs method by E. Sieurin, and was stimulated by the rising interest in powder metallurgy. Early outputs were about 25,000 tons per annum. It




*Wiberg's electrically heated carburettor*

is proposed to enlarge the plant at Höganäs.

Martin Wiberg's first Swedish patent was 46,507 of 1918, using a reducing gas mixture of 2 : 1 $CO/H_2$ ratio made in a special electrically heated carburettor as shown on page 19.

The reducing action with the formation of metallic iron and excess gas together with some exhaust is shown as follows:—

$$\underset{\text{ore}}{3Fe_2O_3} + \underset{\text{reducer}}{4C} + \underset{\text{air}}{2H_2 + 0.1\ O_2} = 6Fe + \underbrace{0.53CO + 0.47CO_2 + 0.26H_2 + 0.24H_2O}_{\text{excess gas}} + \underset{\text{(exhaust)}}{3CO_2 + 1.5\ H_2O}$$

From the sketch it will be seen that, during operation, more gas is produced than is needed for heating the ore; and in order to prevent excessive rise of temperature in the combustion zone, a certain amount of gas is withdrawn from the system before it reaches this zone. This gas outlet must be as high as possible, near the top of the apparatus, in order to use its reducing capacity as long as possible. Hot air from the carburettor is blown in at a temperature of about 950° C. near the top, so that all residual combustible gases are burned.

From 1920 to 1930 semi-full-scale tests were made in several parts of Sweden (Woxna, Sandvikens and elsewhere) and in Spain. The first full-scale plant was erected at Söderfors in 1932 for the production of 10,000 tons of sponge iron per annum, but this plant apparently was only able to achieve continuous operation in 1941. Blowers deliver reducing gas at 700-800° C. These were first made of heat-resistance nickel-chrome alloy. Larger blowers of gas turbine alloy N155 are now being made.

### The Carburettor

The carburettor is described as the heart of the plant, since reducing gas of the correct composition and uniform temperature is of the utmost importance. The carburettors as first designed left much to be desired. A new three-phase type for wood charcoal was installed in 1941. The gas flows from above downward, that is, in the same direction as the charcoal. Electric current is fed through six electrodes and a hot zone is established in the centre of the chamber. Circulating gas flows through a concentric opening in the arched roof and passes to the space between the latter and the charcoal bed, and then flows for the most part along the walls downward, thus surrounding the central hot zone as a fog screen. In the lower and narrower part of the chamber final carburisation takes place.

This plant gave very good performance up to 1945 when it became more than ever necessary to change over to coke in place of wood charcoal. Experiments were somewhat delayed, however, until about 1949, and eventually resulted in the design of a new type, according to Swedish Pat. No. 134,654. Two fundamental differences were due to (a) much higher ash content, and (b) marked differences in respect of electrical properties. Like wood charcoal, the electrical conductivity of coke increases with temperature, but not at the same rate. Whether cold or hot its conductivity is greater than that of charcoal, and it is not therefore possible to use a restricted furnace chamber with close-spaced electrodes. Other differences may also be noted by reference to the description and drawings of the patent cited, showing, among other things, three electrodes in the upper and three in the lower part of the chamber, with transformer-controlled voltages between 110 and 240 V. Special provision is made for dealing with residual ash. Some of the residue after sieving is returned to the plant.

### $H_2S$ Removed

Sulphur in the coke passes for the most part as $H_2S$ into the gas current, and this must therefore be purified, e.g., by sulphur filters consisting of beds of dolomite of suitable size lumps. This has proved an efficient method, using 60 kilos of dolomite per ton of sponge, the latter only containing about 0.002 to 0.004 per cent S. The used dolomite with 5 to 7 per cent S as Ca and Mg sulphides is removed from the lower part of the filter continuously, in order to keep the filter free and unclogged. Dolomite has proved to be better than limestone for the purpose. (*See* also Swedish Pat. Appln. No. 8719/1951.)

The composition of the reducing gas is another matter of importance. In the final reducing zone iron oxide is reduced to metal as follows:—

An improved method for the production of sponge metal, i.e., sponge iron, is claimed in British Patent No. 674,236 (Application date 6.4.49) which has just been published in the name of Stora Kopparbergs Bergslags A/B, Falun, Sweden,

and B. M. S. Kalling and O. J. L. Dragge. A solid reducing agent is used, without sintering, in a horizontal rotary furnace, and a special method of heating is claimed. A mixture of metal oxide ore of suitable particle size and fine granular carbonaceous material (charcoal, coke or coal), is used, the latter in such excess that, on rotation, there is partial separation and a surface layer of carbon material forms, covering the ore and preventing re-oxidation and sintering. Lime may be added to eliminate sulphur. Part of the carbon material and carbon monoxide formed during reduction are burned by means of air blown in as jets. The ore may be charged in the form of pellets or other forms, including moulded balls with suitable binding agent. Various other conditions and directions are given in the specification, including illustrative drawings. The furnace has an outer steel shell and refractory lining, with openings in end walls for feed and discharge. Oxygen or oxygen-enriched air is blown in through nozzles. The discharge mechanism consists of two perforated plates or shovels which on rotation have a withdrawing and screening action, so that a substantial part of the fine material reducing agent can be returned to the furnace, whilst the coarser material, consisting chiefly of sponge metal will be discharged and passes through a sluice arrangement. If there is little difference in particle size between reducing agent and sponge metal, separation is done by known electromagnetic or mechanical means, and if the reducing agent is sufficiently fine at the discharge end it can be returned by blowing in with the oxygen gases. The ore charged in may have been previously melted, solidified and crushed to suitable size.

### Alternative Form

The alternative form, illustrated in the specification, has the oxygen feed pipe disposed centrally in the discharge opening, the latter having a cylindrical screen concentric with the oxygen supply pipe, and a special chamber for collecting particles passing through the screen, and communicating with the oxygen pipe in such manner that, as the furnace rotates, the particle mass collected will be at different levels and can be disposed of as required, including its return by oxygen blast into the furnace.

It has been found that the hydrogen supply can vary between 15 and 35 per cent without much effect on the working. It was found further that with hydrogen reduction alone—in some recent laboratory tests—it proceeds very slowly in the higher stages. Hydrogen supply from coke alone (at about 5 per cent) is of course too low, and a supplementary supply is needed, e.g., by the carburettor acting also as a water gas producer; though this is not entirely satisfactory. The ideal fuel should contain 7.7 $H_2$ and 92.3 per cent C. Anthracite possibly approaches this, but requires a specially designed carburettor. It has been suggested to add to the coke a hydrogen-containing fuel such as fuel oil, natural gas, or coke oven gas. Some tests are now being made at Söderfors in this connection. Another method is to obtain the reducing gas only from mineral oil or natural gas, as is done, for instance, for synthesis gas. The following figures have been obtained:—

| *Reducing agents with 25 per cent hydrogen* | *Fuel consumption per ton sponge iron containing 81 per cent Fe* | |
|---|---|---|
| | Fuel in kilos | Electric energy kWh |
| Coke plus water .. | 225 | 1140 |
| Coke plus fuel oil .. | 111+63 | 940 |
| Coke plus methane .. | 151+41 m³ | 940 |
| Coke plus coke oven gas | 165+75 m³ | 940 |

### Ores Used

In regard to ores used, these must be high iron type in lumps of 25 to 80 mm. with at least 65 per cent Fe, low phosphorus—as this all passes into the sponge—and of sufficient mechanical stability to yield a satisfactory sintered product. Various kinds of ore have been tested at Söderfors. A useful test to determine the suitability for sponge iron manufacture is as follows: 500 g. ore is disintegrated to 10-16 mm. and heated to 950°C. in a rotary tube furnace. Reduction gas is then introduced of such a composition that the ore is reduced to woostite. After 3½ hr. the furnace is filled with nitrogen with the furnace rotating at 66.6 r.p.m., to make a total of about 2,000 revs. After cooling, the material is sifted (10 mm. sieve). It has been found that the residue over 10 mm. shows a good comparison figure for suitability of ore. The residue should be at least 70 per cent and preferably 80 per cent. Among the ores tested, Swedish and other hematites, as well as Canadian Steep Rock ores have proved very suitable—also, fairly dense magnetite. From ores containing up to 67 per cent Fe sponge iron of 90 per cent Fe can be obtained, though this higher purity grade product is somewhat difficult

to achieve under present conditions. Pelleting of the sintered ore is, however, proving very satisfactory in the preliminery treatment of the ore.

It is considered that experience at Södersfors justifies further expansion, and four leading steel-works in Sweden plan to erect iron sponge plants for a total production of 120,000 tons per annum, using sintered pellets from enriched magnetite fines or concentrate. The first of the four plants was in fact working in January, at Sandviken.

## *The Institute of Metals*

### Symposium on Metallic Surfaces

AN all-day symposium on 'Properties of Metallic Surfaces' arranged by The Institute of Metals, will be held in the Lecture Theatre of the Royal Institution, Albemarle Street, London, W.1, on Wednesday, 19 November, 1952, from 9.45 a.m. to 5 p.m.

The papers contributed to the symposium will be discussed at two sessions, as follows:

*Session I—(Morning)*

'Specialised Microscopical Techniques in Metallurgy' by Professor S. Tolansky, F.R.S. (University of London).

'Radioisotopes in the Study of Metal Surface Reactions in Solutions', by Dr. M. T. Simnad (Metals Research Laboratory, Carnegie Institute of Technology, Pittsburgh, U.S.A.).

'The Crystalline Character of Abraded Surfaces' by Dr. P. Gay and Dr. P. B. Hirsch (Cavendish Laboratory, Cambridge).

'Diffusion Coatings' by Mr. D. M. Dovey, Dr. I. Jenkins and Mr. K. C. Randle (Research Laboratories, The General Electric Co., Ltd., Wembley).

'The Nature and Properties of the Anodic Film on Aluminium and its Alloys' by Mr. H. W. L. Phillips (Research Laboratories, The British Aluminium Co., Ltd.).

'Chemical Behaviour as Influenced by Surface Condition' by Dr. U. R. Evans, F.R.S. (Cambridge University).

'The Effect of Method of Preparation on the High-Frequency Surface Resistance of Metals' by Dr. R. G. Chambers and Dr. A. B. Pippard (Royal Society Mond Laboratory, Cambridge).

*Session II.—(Afternoon)*

'The Influence of Machining and Grinding Methods on the Mechanical and Physical Condition of Metal Surfaces' by Mr. P. Spear, Mr. I. R. Robinson and Mr. K. J. B. Wolfe (The B.S.A. Group Machinability Laboratory, B.S.A. Tools, Ltd., Birmingham).

'The Effect of Lubrication and Nature of Superficial Layer After Prolonged Periods of Running' by Dr. F. T. Barwell (Lubrication Division, Mechanical Engineering Research Organisation, Department of Scientific and Industrial Research, Glasgow).

'The Effect of Surface Conditions on the Mechanical Properties of Metals, Mainly Single Crystals' by Professor E. N. da C. Andrade, F.R.S. (Royal Institution, London).

'The Effect of Surface Condition on the Strength of Brittle Materials' by Professor C. Gurney (University College, Cardiff).

'The Influence of Surface Condition on the Fatigue Strength of Steel' by Mr. R. J. Love (Motor Industry Research Association, Brentford).

'The Influence of Surface Films on the Friction and Deformation of Surfaces' by Dr. F. P. Bowden and Dr. D. Tabor (Cambridge University).

Attendance at the meeting will be free to all who are interested in the subject. Non-members of the Institute who wish to register for the meeting should apply to the Secretary, The Institute of Metals, 4 Grosvenor Gardens, London, S.W.1.

## *Patents in Powder Metallurgy*

THE technical difficulties that still harass progress in powder metallurgy and related fields are constantly being tackled by different inventors. These results are embodied in several recent patents. Among the latest in the list are (application dates are in brackets):

Sintering of metal powders, B.P. 674.055 (16.11.48), W. P. Williams, for Soc. Edras, Casablanca, Morocco.

Manufacture of self-lubricating metallic bodies by sintering metal powders, B.P. 674.056 (16.11.48) W. P. Williams, etc., as above.

Hard alloys, B.P. 674,219 (26.4.49), Austria, Metro-Cutanit Ltd.

Sintered hard metal alloys, B.P. 674,229 (9.1.48 Czech.), Skoda Works—with numerous earlier patents.

Bonding sintered powdered metal material to steel backing plate. B.P. 674,279 (27.5.49 U.S.), the Raybestos Co.

Manufacture of titanium carbide, B.P. 674,429 (11.1.50), Kenna-metal Inc.

# The Plating of Aluminium Articles

## Electrodeposition as a Production Process

AT the Spring Conference of the Institute of Metal Finishing at Eastbourne this year, Mr. A. W. Wallbank, B.Sc., F.R.I.C., managing director of the Ionic Plating Co., Ltd., of Birmingham, presented a paper on the electrolytic plating of aluminium articles as a production process. The following is a résumé of that paper:—

The plating of aluminium is an example of those processes which were first established by empirical means and only very much later formulated scientifically. This type of plating is a legacy of the early days of plating which has persisted in the plating shops of the Midlands and the North, but which has yet to be equalled in its own particular field by any process of laboratory origin. One remarkable feature about it is the limited extent to which it is known. It is widely known on many shop floors, dimly appreciated in a few works laboratories, but, until recently, quite unheard of in research organisations. Commercial interests have also been strangely unaware of the process, and from time to time such statements as 'Aluminium can be plated at last' appear in print, despite the fact that every hollow-ware counter in the stores of this country has been loaded for the last two decades with chromium-plated aluminium goods.

### Not Inexhaustible

It is now common knowledge that the world's supplies of many metals are not inexhaustible; that, indeed, certain metals will become so scarce that they can only be spared for use as alloying constituents, or as a protective or decorative film on the more common metals. The metals sufficiently plentiful to be the basis metals of the future are very few and it appears certain that aluminium is destined to become second only to iron in this category. It is, therefore, vitally important that electrodepositors should have at their disposal the finishing techniques which will enable aluminium to be freely employed as a basis metal no matter what protective, decorative or functional finish may be required.

Research on the plating of aluminium has been conducted over a number of years, though not upon the successful commercial process. Some excellent papers have already resulted from this research work but the processes investigated and advocated by these workers have many defects compared with the traditional commercial process, and they have therefore only been adopted on a very limited scale by companies unaware of the older method.

### Commercial Process Best

It is, therefore, abundantly clear that, to accelerate development of a good technique for the plating of aluminium in order to meet the requirements of industry, research workers should be given the opportunity of basing their investigations on the commercially proven process. They should then quickly be able to rationalise its more obvious anomalies and sift from it the vital details which contribute to success, thereby developing a far better and more easily controllable process than could ever result from trial and error in the plating shop.

There are at least four difficulties which must be overcome before a successful plating process can be operated upon aluminium.

(1) The aluminium surfaces rapidly acquire an oxide layer when exposed to air or water and this layer tends to inhibit good adhesion of an electrodeposited film.

(2) Aluminium is one of the more anodic metals. There is therefore a tendency to form unsatisfactory immersion deposits in the first seconds of exposure to a plating solution of one of the more negative metals. For the same reason it becomes vitally important that any electrodeposit on aluminium shall be continuous, or the basis metal exposed at pores will corrode preferentially, and set up severe local attack, which will spread along the interface and cause complete breakdown.

(3) Aluminium has few commercial applications in its pure state. It is usually alloyed with other metals and the range of alloys of aluminium with which a plater would be expected to deal is very great. A plater working on steel or brass rarely has to modify his plating procedure to accommodate differences in carbon content, or in zinc/copper ratio. He only encounters difficulty in the comparatively rare cases of the

higher alloy steels or the leaded brasses and special bronzes. With aluminium, on the other hand, he is far more likely to meet with high manganese, copper, magnesium or silicon alloys than with the pure metal. The reaction of aluminium is markedly affected by its alloy constituents, and a successful commercial process must therefore accommodate what are in effect widely different metals.

(4) Finally, the 'plateability' of aluminium is affected by its physical and metallurgical history. Most platers are already only too well aware of the difficulties inherent in castings whether sand, gravity or pressure-die, and these difficulties apply equally to cast aluminium, while even wrought aluminium alloys vary in their reaction to the cleaning and plating sequence according to their previous work-hardening and heat treatment.

### Plating Methods

Methods for plating aluminium are very prominent in plating literature, and most of them depend either upon deposition of a metallic film by immersion, which film is used as the base for subsequent electroplating, or upon anodising followed by modification of the anodic film to enable the electrodeposit to adhere to the basis metal. The most popular of the immersion methods is that using sodium zincate and this has been extensively studied by a number of investigators including Bullough and Gardam,[1] Keller and Zelley,[2,3] and Bailey.[4] It was originally patented by Hewitson[5] in 1927.

The anodising method has been described by Close,[6] and earlier by Fischer,[7] and several variants have been patented.[8,9,10]

In the hands of competent platers, any of these methods are capable of giving good results, but they each have serious defects when considered as commercial plating processes. Deposition of a film by immersion relies essentially upon the single electrode potential of the basis metal. If that metal is uniform, an even immersion film will result, but any local variations in the basis metal, so that two closely adjacent areas have different electrode potentials, must inevitably affect seriously and uncontrollably the character and thickness of the immersion film. In commerce, few aluminium articles are sufficiently homogeneous to guarantee a satisfactory immersion film. Very many articles are indeed constructed from different aluminium alloys which may have been subjected to different degrees of cold working and heat treatment. Still worse, it is not uncommon for an aluminium article to have steel, brass or solder in some part of its assembly. Again, an article to be plated must be suspended on a conducting wire or jig and the contact between that wire and the article itself is an area of differing electrode potentials. No plater can be expected always to use aluminium wire of the same material as the article he is plating. Hence, if the success of any of the immersion processes depends essentially upon a thin, uniform and adherent initial film, commercial adoption of these processes will tend to be limited to the plating of simple wrought aluminium components.

The anodising process is also inapplicable to complex assemblies, as the anodising treatment will inevitably attack preferentially any part of the assembly which is not aluminium or a high-aluminium alloy. It will obviously necessitate the use of aluminium wires and jigs, and equally obviously, the cost of production will be equivalent to superimposing a plating process upon an anodising process. Like the immersion processes, it will most readily be applicable to homogeneous wrought aluminium articles.

The first workers on the process to be described are believed to have been German, but it was a Norwegian, B. Vogt, who first began to develop it on a small scale at Newcastle-on-Tyne in about 1929. Vogt, with the assistance of an able team of practical platers, soon had sufficient confidence in the process to bring it to Birmingham. There, with great courage and resource, he built up a fine business with over 100 employees engaged on the plating of aluminium. His layout, his use of conveyors, and his adoption of semi-automatic equipment were far ahead of his time, but the outbreak of war and the attack on Norway caused him to leave a trade that could ill spare him.

### Process Spread Rapidly

As the men trained by Vogt began to spread throughout the plating trade, the process was adopted by many other companies and became quite widely used, although it has only twice been the subject of technical papers. The first occasion was an unpublished review before the Birmingham branch of the Electrodepositors' Technical Society

by Vogt himself in about 1936; more recently a detailed description of a process of the Vogt type has been published in the technical Press by Fyfe.[11]

The process is in line with modern views in agreeing that the best foundation for an adherent deposit is a thin, uniform, and continuous layer of zinc. It does not, however, rely on immersion for this film, but on an applied current. The zinc is thereby deposited evenly over every part of the article being plated, whether its components are cast or wrought, pure or alloyed, soldered or riveted. This zinc film is too thin to withstand a nickel plating solution and it is therefore reinforced by a thin deposit of brass.

The nickel solution which follows is very low in chloride and is operated under conditions which yield a soft, unstressed deposit. The adhesion of the nickel is enhanced by stoving, after which the article can be mopped and chromium plated in the normal way.

**Cleaning Sequence**

Trichlorethylene may be used for very greasy work or as an operation in the polishing shop between mopping and colouring. It is not normally included in the cleaning sequence. This consists of:—

(a) First electrolytic clean; (b) swill; (c) acid etch; (d) swill; (e) second electrolytic clean; followed by plating sequence.

(*a*) *First electrolytic clean*:

| | |
|---|---|
| Composition : | |
| Caustic soda | 4.5 oz./gal. (28 g./l.) |
| Sodium cyanide | 4.5 „ (28 „ ) |
| Sodium carbonate | 2.25 „ (14 „ ) |
| Conditions : | |
| Temperature | 70°F. |
| Voltage | 7 volts cathodic. |
| Time | 3-5 min. |
| Anodes | Sheet steel. |
| Tank | Steel unlined. |

Control:

No analysis. The bath is regenerated two or three times and then replaced. The solution surface is skimmed daily.

(*c*) *Acid etch*:

| | |
|---|---|
| Composition : | |
| Sulphuric acid, R.O.V. | 50 per cent by volume. |
| Nitric acid, conc. | 50 per cent by volume. |
| Conditions : | |
| Temperature | Room temperature. |
| Time | 2-5 seconds. |
| Exhaust | Venturi. |
| Tank | Earthenware. |

Control:

None: The solution is replaced when no longer effective.

(*e*) *Second Electrolytic Clean*:

| | |
|---|---|
| Composition : | |
| Caustic soda | 2.25 oz./gal. (14 g./l.) |
| Sodium cyanide | 2.25 „ (14 „ ) |
| Condition : | |
| Temperature | Room temperature. |
| Voltage | 7 volts cathodic. |
| Time | 10-30 seconds. |
| Anodes | Sheet steel. |
| Tank | Steel unlined. |

The success of the cleaning sequence and indeed of the whole process depends largely upon the skill, experience and care of the operator. The times of immersion are varied by a good operator to suit different types of work, and the presence or absence of soldered joints; his acquired knowledge enables him to judge from the appearance of the work at each stage whether that stage is satisfactory or not. Similarly he can assess by watching his work when a particular solution should be regenerated or replaced.

*Preliminary Plating Sequence.*—The plating sequence is:—

(*f*) Zinc plate; (*g*) brass plate, (*h*) swill, (*i*) swill, (*j*) nickel plate, (*k*) swill.

(*f*) *Zinc Plating*:

| | |
|---|---|
| Composition : | |
| Zinc chloride | 0.08 oz./gal. (0.5 g./l.) |
| Sodium cyanide | 0.08 „ (0.5 „ ) |
| Caustic soda | 1.7 „ (10.5 „ ) |
| Conditions : | |
| Temperature | Room temperature. |
| Current | 5 a.s.f. |
| Time | 20 seconds. |
| Anodes | Sheet zinc (taken out between loads). |
| Tank | Unlined steel. |

Control:

No analysis. The sole method of control is by appearance of work which should be a uniform bronze colour. If the deposit becomes blue-black the zinc deposit is too thick and the solution needs dilution.

(*g*) *Brass Plating*:

| | |
|---|---|
| Composition : | |
| Copper acetate | 2.0 oz.gal. (13 g./l.) |
| Zinc chloride | 2.0 „ ( „ |
| Sodium cyanide | 5.0 „ (31 „ |
| Sodium carbonate | 1.5 „ (9 „ ) |
| Sodium bisulphite | 2.0 „ (13 „ ) |
| Conditions : | |
| Temperature | 80°-90°F. |
| Current | 7-10 a.s.f. |
| Time | 8 seconds. |
| Anodes | Sheet 70/80 brass. |
| Tank | Unlined steel. |

(*h*) & (*i*) *Double Swill*:

The rise between brass plating and nickel plating must be very quick and very thorough. The customary acid dips which are interposed between cyanide and nickel solutions cannot be used on such thin flash deposits.

(*f*) *Nickel Plating*:

| | | | |
|---|---|---|---|
| Composition : | | | |
| Nickel sulphate | .. .. | 40 oz./gal. | (250 g./l.) |
| Magnesium sulphate | .. | 16 " | (100 " ) |
| Sodium chloride | .. .. | 0.75 " | ( 49 " ) |
| Boric acid | .. .. | 4 " | ( 25 " ) |
| Conditions : | | | |
| Temperature | .. .. .. | 115°F. | |
| Current | .. .. .. | 10-15 a.s.f. | |
| *p*H | .. .. .. | 5.6. | |
| Filtration | .. .. | Continuous pressure filtration through kieselguhr. | |
| Agitation | .. .. .. | Air. | |
| Anodes | .. .. .. | Depolarised, bagged. | |
| Tank | .. .. .. | Steel, rubber-lined with lead-covered steam and pipes. | |
| Anode area | .. .. .. | Three times cathode. | |
| Rate | .. .. .. | 0.0001 in. in 12 min. | |

Control:

*p*H twice daily. Solution analysed twice weekly. When deposit becomes hard and bright the solution is purified by the Liscombe method.

*Stoving and Subsequent Plating.*—After rinsing and draining, the nickel-plated articles are stoved for half an hour at a temperature of 450° F. It is claimed that this treatment 'makes a good deposit better and a bad deposit worse,' and it is certainly true that if an article is free from blisters after stoving, it can be nickel finished and chromium plated without fear of 'lifting' at a later stage. Once stoving has been completed the nickel-plated article can be given any sequence of subsequent deposits or of finishing treatments.

*Reclamation of Rejects.*—With good operators the incidence of rejects is no higher with aluminium than with other basis metals, and such rejects as do occur can be stripped for replating comparatively easily. This can be achieved either by a reverse sulphuric strip in the normal way or by careful immersion in 50 per cent by volume nitric acid.

*Applicability to Alloys.*—One of the great advantages of the process is that the great majority of aluminium alloys can be plated through exactly the same sequence. Some of them darken during the cleaning stage, but the adhesion of the final deposit is not affected. Alloys containing more than 3 per cent magnesium are the only doubtful range, but even these are possible if care is exercised during the cleaning.

It is hoped that a critical investigation of this process will first eliminate its defects, and, then develop from it a far better, simpler and quicker process.

The greatest drawback to the process is its dependence on the training and intelligent observation of the operator. At present his skill is far more vital to the success of the process than the chemical or physical control and, therefore, fully automatic plants for plating aluminium would be a risky undertaking. This reliance on the personal craft of the operator is obviously the first point at which the research attack should be directed.

In the process itself, the cleaning sequence is reasonable and the pre-plating baths are quick and effective, but their formulation is archaic. At the time when this process was first developed brass and zinc solutions of this type would not be uncommon, but they are certainly anachronistic in 1952. Surely systematic investigation will rapidly discover what is the optimum range of the substances in solution and thereby deduce a more rational method of make-up and control.

The nickel solution is very good—it is indeed one of the best general-purpose nickel solutions in use today. It might be possible to modify it to increase current density or gain brightness without undue stress, although in the present state of nickel supplies a more fruitful line of investigation would be to follow a thin deposit of nickel from this solution with some of the deposits or combinations of deposits now being adopted as alternatives to nickel/chromium.

### Related to Porosity

The most important line of research in this subject is, however, closely allied to the fundamental causes of porosity in plated deposits. Plated aluminium has been widely used on hollow-ware domestic articles subject to frequent washing and cleaning and it has been successful in this field. It has also been employed for functional engineering purposes with reasonable success; for instance, the Tourist Trophy has been won on several occasions by motor-cycles with nickel/chromium-plated pistons, but its application to articles subject to the full severity of the weather has been very limited. Before the war, many bus fittings, exterior and interior, were of plated aluminium and lasted very well, but the car and cycle industries have been reluctant to adopt it until more evidence of its performance is available.

When a plated aluminium surface is exposed to the weather a pore may be more serious than on steel or brass, as the corrosion appears to spread along the interface

and destroy adhesion over a wide area. This is often allied to thick, unsatisfactory zinc deposits such as are common with the immersion method and it can be claimed for the electrolytic method that it has appeared to last better on exposure tests than its modern rivals. However until there is a more definite lead from research the only safe method is to deposit an adequate thickness of metal on aluminium to ensure minimum porosity.

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[1] W. Bullough and G. E. Gardam, *J. Electrodepositors' Tech. Soc.*, 1947, 22, 169.
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[3] F. Keller and W. G. Zelley, *J. Electrochem. Soc.*, 1950, 97, 143.
[4] G. L. J. Bailey, *J. Electrodepositors' Tech. Soc.*, 1951. 27, Advance Copy No. 10.
[5] E. H. Hewitson, U.S. Patent 1,627,900. 1927.
[6] G. C. Close, *Light Metal Age*, March, 1946, 4.
[7] J. Fischer, *Metallwirtschaft*, 1932, 11, 473.
[8] W. J. Travers, U.S. Patent 1,971,761. 1934.
[9] J. Fischer, U.S. Patent 2,036,962. 1936.
[10] E. M. Julick and W. A. Mehmel, U.S. Patent 2,430,468. 1947.
[11] R. Fyfe, *Metal Industry*, 1950, 77, 300.

## *Production of Metallic Gallium*

METHODS of producing gallium in metal form have recently been the subject of several British Patents (*see* also CHEMICAL AGE, *66*, 926). In B.P. 674,036, by Brown, a method is claimed for preparing solutions for the recovery of metallic gallium from various minerals, by dissolving these in aqueous 10-20 per cent NaOH or KOH, and for dealing with the preponderating amounts of alumina or aluminate also present (*see* also author's B.P. 674,101 and Frary's 671,356). The gallium oxide and alumina are co-precipitated by the addition of an acidic material such as carbon dioxide. This co-precipitate is separated, all heated to at least 300°C., and dissolved in an aqueous solvent. Alternatively, enough of the alkali metal aluminate is converted to hydroxide and insolubilised aluminium before co-precipitation, so as to make the atomic ratio of dissolved aluminium and dissolved gallium range from 25:1 to 100:1.

Again, in B.P. 674,039 by Brown, the author proposes that, after co-precipitating the two oxides (Ga and Al) in hydroxide solution as above, part of the dissolved gallium should be electro-deposited from the resultant solution as metal. The residual solution left after this deposition is mixed with additional aluminate solution containing more dissolved Ga. This mixture is used again as before.

## *U.S. Manganese Recovery*

### Open Hearth Slag Discussed

AT a recent meeting of the American Iron and Steel Institute recovery was discussed of some at least of the 770,000 tons of manganese contained annually in the country's open hearth slags and mostly dumped. Three possible methods are being studied, according to Mr. S. Marshall of the U.S. Steel Corporation, of which two are chemical. The first consists of a preliminary clinkering with lime, followed by leaching with ammonium carbonate, as carried out in some experimental work at the Bureau of Mines Station at College Park, Md. The material, clinkered at 2800°F., is subjected to a reducing roast at 1300°F. to yield manganese oxide, which is then converted to manganese carbonate, with recovery of ammonia.

Both pyro-metallurgical and chemical techniques are being applied at the Armour Research Foundation of the Illinois Inst. of Technology. The slags are treated with solid or gaseous chlorides at a temperature high enough to volatilise iron and manganese chlorides. The latter may be condensed on a cold surface, or dissolved in water for subsequent separation, to produce very pure manganese oxide and either high grade iron powder or oxide. Hydrogen chloride is synthesised from its constituent elements—generated by electrolysis of brine—in a suitable reactor where it is hoped sufficient heat would be generated for the process.

### CaCl Mixture Proposed

The U.S. Steel Corporation proposes using a mixture of calcium chloride and slag fed into a furnace at 1400-1500°C. As furnace contents are liquid, no sizing is necessary. A flush gas such as nitrogen is required, and 89 per cent of the manganese can be recovered. Volatilised chlorides are condensed and dissolved in water, and flush gas returned to reactor. The chloride solution is treated with limestone to *p*H 4, with precipitation of iron hydroxide. The solution may be filtered and treated with lime to raise the *p*H to 8, when manganese hydroxide will precipitate. Both the Fe and Mn slurries are passed separately through standard thickeners and filters. The calcium chloride is recovered.

# HOME

### Change of Address

Imperial Chemical Industries, Ltd., announces that its Central Publicity Department moved on 23 June to the North Block (ground floor) of Thames House, Millbank, S.W.1, telephone VICtoria 4486. Written communications should, however, be addressed to Imperial Chemical House, Millbank, S.W.1.

### Society of Cosmetic Chemists

The fourth annual general meeting of the Society of Cosmetic Chemists of Great Britain, which is an associate of the Society of Cosmetic Chemists, U.S.A., was held at the St. Bride's Institute on Friday, 13 June, 1952. Mr. W. A. Poucher was unanimously elected as the Society's first honorary member.

The following officers and members of council were elected for the year 1952/53: chairman, Dr. R. H. Marriott, D.Sc., F.R.I.C.; vice-chairman, F. V. Wells, F.C.S.; hon. secretary, F. Hulley; hon. treasurer, E. Polàn; members of council: A. B. Bell, B.Sc., A.R.I.C.; H. W. Hibbott, M.Sc., Ph.D., A.R.I.C.; H. Holmes; A. W. Middleton, B.Sc., Ph.D., F.R.I.C. and J. Pickthall, F.R.I.C.

### Inquest Adjourned

After accidentally inhaling an arsenical gas (arseniuretted hydrogen) while at work on 20 June, one man died in hospital two days later, while five other men, admitted to hospital on the same day, are also suffering from the effects of the gas. All are employees of William Harvey and Co., Ltd., tin smelters, Mellanear Works, Altcar Road, Bootle (Lancs). The inquest opened on 23 June, was adjourned until 21 July.

### Royal Visitor

The Sultan of Brunei, who is making a tour of Britain, visited the Shell refinery at Stanlow, Cheshire, on 20 June. The Sultan is head of an independent Malay State which has been under British protection for over 60 years. Its oilfield, now the greatest in the Commonwealth, was discovered in 1929, extending for five miles along the beach and nearly one mile inland. Brunei is now producing more than 100,000 barrels of crude oil a day.

### Library Hours

From 16 July until 30 September the Library of The Chemical Society will be open from 10 a.m. to 5 p.m. daily, except during the fortnight 4 to 16 August inclusive, when it will be entirely closed for revision and cleaning.

### Industrial Design Appointments

The Board of Trade announce that the President has appointed the Right Honourable Lady Sempill, Miss Mary Grieve, Mr. George Breeze, Mr. Lynton H. Lamb and Mr. Walter Lines to be members of the Council of Industrial Design. He has also re-appointed Mr. Geoffrey Dunn, Mr. Leslie Gamage, M.C., Mr. John Gloag, Mr. G. W. Lacey, C.B.E., B.Sc., F.R.I.C., Sir William Palmer, K.B.E., C.B., Major F. J. Stratton, C.B.E., and Dr. W. J. Worboys, B.Sc., Ph.D., to be members of the Council on the termination of their existing appointment.

### Oldham Outing

When more than 1,000 employees of Oldham & Son, Ltd., the storage battery makers of Denton, Manchester, went to Blackpool on Saturday 14 June for their annual outing, they had nothing to pay and 15s. each as spending money. In addition, everyone was provided with admission tickets for various places of amusement. Thirty motor coaches were needed to transport the large party. Mr. Edward C. Oldham, one of the Company's three joint managing Directors, was present with Mr. S. J. Wrigglesworth, director and general manager (who presided), and Mr. W. Elkin Platt, director.

### Tungsten Ore Selling Price

Selling price for tungsten ore of standard 65 per cent grade and ordinary quality was reduced on 26 June from 500s. to 467s. 6d. a long ton unit delivered consumers' works, based on the current buying price of 445s. a long ton unit c.i.f. Difference between the buying and selling prices is accounted for by the cost to the Ministry of Materials of freight, storage, handling and agents' commissions. It is also influenced by the provision for liabilities assumed by the Ministry as a result of its policy of forward buying to assure supplies of tungsten ores to British industry.

# OVERSEAS

### Krilium for Canadians

Arnold H. Smith, president of Monsanto Canada, Ltd., has announced that production of a formulation of Krilium, developed especially for home-gardening, will begin at the company's Montreal plant soon. Known as the Merloam formulation, 'it is especially useful in home-gardening because of its ability to create and maintain greatly improved soil workability', Mr. Smith said.

### To Treble Output

Output at the new cement works at Chilanga, near Lusaka, in Northern Rhodesia, is to be trebled. Started jointly by the Northern Rhodesian Government and the Colonial Development Corporation two years ago, the plant is producing 55,000 tons of cement a year. A new kiln twice the size of the present one is to be installed, and will be in production by 1954. Seven new slurry silos and two new cement storage silos will also be erected.

### U.S. Synthetic Fibre Production

Output of synthetic fibre in the U.S.A., excluding rayon, is expected to rise to nearly 1,000,000,000 lb. by 1960 and four times that amount by 1975, according to the Materials Policy Commission. Rayon production is indicated at about 3,000,000,000 lb. by 1975, almost three times the present level. In the 25-year forecast based on 1950 it was estimated that cotton consumption aided by the increased use of synthetic finishing agents would maintain present levels and wool consumption would decline slightly.

### Slag Wool Factory

Bradford Insulation (South Africa) (Pty.), Ltd., anticipate that their new £50,000 factory at Randfontein, Transvaal, will be in production towards the end of this year, manufacturing slag wool and similar products, the first of its kind in South Africa.

The slag wool is to be supplied to the new South African industry that is to produce oil from coal and it is expected that a big market will be found with a number of other local industries. It is also planned to develop the export markets.

### Sindri Fertiliser Factory

The Sindri fertiliser factory owned by the Indian Government is expected to go into full production of 1,000 tons a day by November this year, it is reported. During question time in the Indian Parliament, the Minister of Production said that so far the factory had produced 52,565 tons of ammonium sulphate.

### America's Rubber Requirements

A tremendous increase in synthetic rubber production to meet a world demand for more than double the quantity required in 1950 is anticipated in the next 25 years by the Materials Policy Commission. For natural rubber an expansion of only 25 per cent is forecast. By 1975 it is expected that the U.S. demand for new rubber will nearly double to 2,500,000 long tons, and the country is said to have raw materials sufficient to meet that quantity entirely from synthetic rubber.

### Indian Export Controls

The export of gypsum and pyrites from India has been prohibited by the Joint Chief Controller of Imports and Exports in Calcutta. The export of manganese dioxide is permitted up to the end of October this year to all permissible destinations, provided evidence is produced that the stocks are ready at the port for shipment.

### First Shipment Arrives

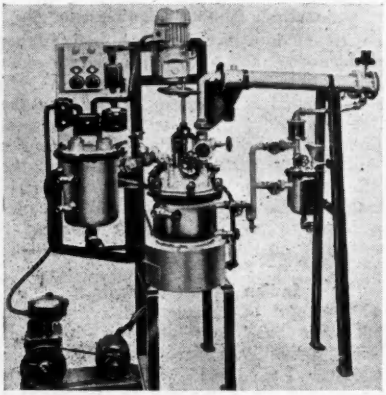
The first machinery from overseas for the £20,000,000 oil-from-coal plant at Sasolburg, South Africa, was unpacked at Coalbrook early in June by the advance guard of the American technicians who will superintend the construction. More plant will be arriving soon from Germany and the U.S.

### Indian Oil Expansion Approved

The proposed expansion scheme for the oil refinery belonging to the Standard Vacuum Oil Company on Trombay Island, off Bombay, has recently received the approval of the Government of India. The project will be speeded up and production will be commenced earlier than had been thought. Under the scheme capacity is being increased from 19,000 to 25,000 barrels per day.

# Publications & Announcements

SHOWN in the accompanying photograph is a small pilot plant operated by R. & W. Winter & Co., Ltd., of South Africa, exhibiting a Stabilag heating jacket made by Stabilag Limited. The pilot plant is used for research in a paint works, and the jacket demonstrates that this form of heating is tailor-made to fit the contour of the vessel being heated and hence can give uniform distribution of heat all over the surface.



Other recommended uses of these heating mantles are on fume bends and condenser columns to prevent the building up of resin; on drain-off valves, which are the cause of frequent trouble; for valves and pipelines carrying viscous liquids; and for the heating of sight glasses to prevent crystallisation on the glass. Maximum temperatures obtainable with these jackets are 500-700° C.

* * *

CORNIGLIANO, the cornerstone of Italy's steel rehabilitation plan, which is due to come into operation this year, is described in a survey of the Italian iron and steel industry contained in the *Monthly Statistical Bulletin* for April (Vol. 27, No. 4), published by the British Iron and Steel Federation. The 500,000-ton Cornigliano plant, in the building and planning of which British and American engineers have assisted will cost about £45,000,000, and when in full operation will employ some 3,000 workers.

CRANE Packing, Ltd., have recently issued a special booklet devoted to gland packings for the chemical industry. Some months ago a combination assembly of gland packings which was supplied by Crane Packing, Ltd., of Slough, England, was installed in a pump handling sulphuric acid with very successful results. They have so far given some seven months' trouble-free service. The CF2 range of packings, which were introduced by the Crane company about two years ago, are based upon polytetrafluorethylene.

* * *

SODIUM BENZOATE as a corrosion inhibitor is the subject of a new booklet issued by Monsanto Chemicals, Ltd. One of the most interesting developments has been the complete protection given to metallic objects when wrapped in materials incorporating this chemical. Suggestions made in the booklet are based on conclusions reached after extensive laboratory and service investigations and photographs of test specimens are given. Sodium benzoate is also valuable as an anti-corrosive incorporated in heat exchange media, adhesives, textile emulsions, and solutions for preventing the corrosion of surgical instruments.

* * *

ACCURATE analysis of the $CO_2$ content of flue gas is essential for determining the efficiency of conversion of fuel into heat, and a glass $CO_2$ indicator that makes this operation extremely fast and simple is the 'Fyrite', distributed by the Shandon Scientific Company. This handy instrument provides a convenient method for checking automatic combustion controls and ensuring that the correct adjustments in air supply for quality of fuel or number and size of burners are made. The operation of the instrument consists of four simple movements occupying about 40 seconds all told. The principle of operation is the absorption of $CO_2$ into a fluid, which causes a partial vacuum and so affects the level of the fluid. Accuracy is claimed to be $\pm$ 0.5 per cent. General use of such an instrument throughout the industry could save millions of tons of fuel each year, as it is already doing in the U.S.A. Most of the leading chemical and other firms in this country are in fact using it.

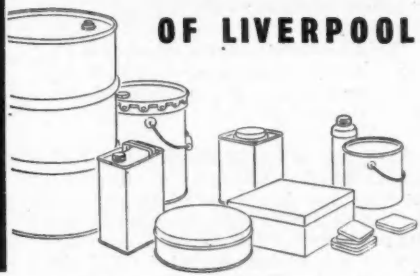
The most satisfactory container for the product

Devising protection for a soft and delicate fruit can have been no easy problem, yet Nature found the perfect answer. The tough, resilient banana skin is proof against bird, blight and climate alike . . . it is, in fact, a perfect example of a well designed container.

We, too, have produced many equally satisfactory metal containers in the last 83 years. So many, in fact, that our standard range includes numerous types of ferrous and non-ferrous metal containers now in common use, and containers to new specifications are being devised regularly to meet special requirements. Whether the need is for a half-ounce tin or a fifty gallon drum . . . if the finish is to be plain, painted or lithographed . . . or if special internal treatment is called for—Reads of Liverpool will supply or can design a container to suit the product.

# READS

## OF LIVERPOOL



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# • PERSONAL •

Petrochemicals, Limited, announce that MR. GODFREY H. OWTRAM has joined the board of the Company and has been appointed managing director. Mr. Owtram is 45 years old and comes from a well-known Lancashire family. He has had wide administrative experience in the textile, engineering and chemical industries. He is chairman of Peter Crook, Ltd., fine cotton spinners of Farnworth, Lancs, and a director of Yorkshire Dyeing and Proofing Company and associated companies. He was a founder of New Metals and Chemicals, Ltd.

United Steel Companies, Ltd., announces that MR. H. E. WRIGHT retired from the position of general manager of its Steel, Peech & Tozer branch at Rotherham on 30 June, 1952. Mr. Wright joined the company 38 years ago at the Appleby-Frodingham branch and has been with Steel, Peech & Tozer since 1925. He is remaining with The United Steel Companies, Limited, in a consultative capacity, and will continue to serve on the boards of the associated companies of which he is at present a director. In addition, he is to supervise the development of commercial research at the head office. MR. ANDREW JOLLIE, who was general works manager, succeeds Mr. Wright, and MR. G. E. D. HALAHAN, who was chief labour superintendent of the United Steel Companies, succeeds Mr. Jollie as general works manager.

The directors of Johnson, Matthey & Co., Ltd., announce the appointment of MR E. G. PICKERING as a joint managing director of the company, as from 1 July, 1952.

MR. J. ALAN NASMITH, B.Sc.Tech., Assoc.I.Mech.E., A.M.C.T., of Manchester, has been elected chairman of the council of the Textile Institute in succession to MR. ALLAN DRAPER, F.T.I. (Worsley, near Manchester), who has been elected vice-chairman. Mr. Nasmith, who joined the institute in 1936, became a member of the council in 1948. He is chairman of the diplomas committee and serves on a number of other committees. He is executive manager of the advisory committee of the American Society of Mechanical Engineers. MR. W. KERSHAW, F.T.I. (Manchester), and MR. R. J. SMITH, F.T.I. (Cheadle Hlume), have been re-elected respectively honorary secretary and honorary treasurer of the institute.

Two departmental chiefs at C. E. Fulford, Ltd., manufacturing chemists, Carlton Hill, Leeds, are retiring with a combined service of 98 years with the firm. They are MR. W. RICHMOND, advertising manager for the past 13 years, who has 51 years' service, and MR S. W. FITZGERALD, chief chemist, with over 47. To mark their retirement they were given a presentation by Mr. R. T. Fulford, only son of the founder, who is on a visit to Leeds from Canada where he is head of the Canadian business. Though they are retiring they will be retained as consultants.

A Student's Essay Prize for 1952 has been awarded by the Council of the Institute of Metals to MR. JOHN C. WRIGHT, Development and Research Department, The Mond Nickel Co., Ltd., Birmingham, for an essay on 'The Metallographic Investigation of Failed High-Temperature Components.' The prize of twenty guineas will be given in the form of ten guineas in money and ten guineas in books to be selected by the prize winner.

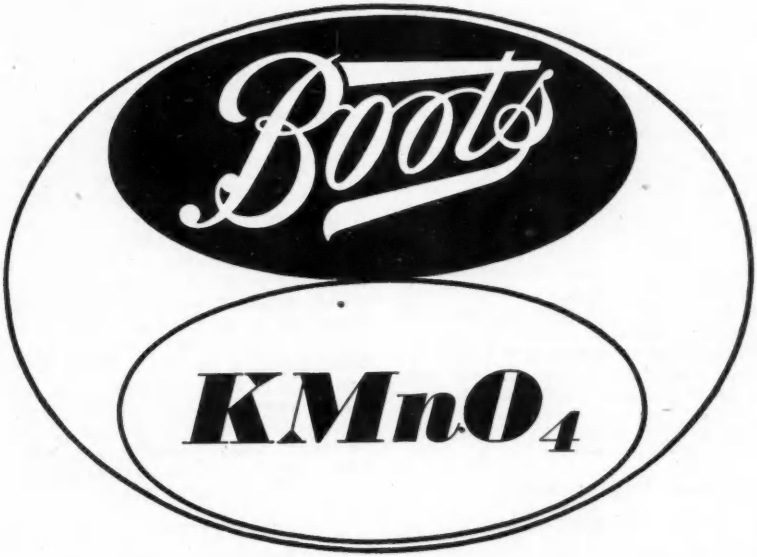
Mackay Industrial Equipment Limited of Feltham, announce that MR. H. H. MONTGOMERIE, C.B., O.B.E., former Under Secretary, Ministry of Works, has accepted an invitation to join the Board in an advisory and consultative capacity.

## *Obituary*

The death occurred on 27 June in a Glasgow nursing home of MR. JAMES S. M. GRIEVE, who was a director of the Milroy Chemical Company, Ltd., Bridgeton, Glasgow, and had been in business in Glasgow for more than 40 years. Born in Edinburgh, he had a distinguished career as a mason, being twice master of the Trades House Lodge of Glasgow and serving for many years as substitute grand master of the Province of Glasgow.

# Potassium Permanganate

## B.P. AND TECHNICAL

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# Commercial Intelligence

**The following are taken from the printed reports, but we cannot be responsible for errors that may occur**

## Mortgages and Charges

**(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages or Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary but such total may have been reduced.)**

SILICA GEL LTD., London, W. (M., 28/6/52). 23 May, mortgage and charge to Midland Bank, Ltd., securing all moneys due or to become due to the Bank; charged on factory premises and land being part of Hollygrove Works, Staines Road, Hounslow, with trade machinery, fixtures, etc.; also a general charge. *£15,000. 12 November, 1951.

VACUUM OIL CO., LTD., London, S.W. (M., 28/6/52). 23 May, charge, to Finance Corporation for Industry, Ltd., securing £250,000 or such less sum as may from time to time be outstanding and all other moneys due to chargees pursuant to an agreement dated 16 May, 1952; charged on benefit of an agreement dated 22 January, 1952, for the building and equipping of a tank ship and the company's interest, present and future in the property comprised therein. *Nil. 3 July, 1951.

# New Registrations

### C.R.M.C. Laboratories, Ltd.

Private company. (508,880). Capital £100. Analytical chemists, metallurgists, consulting engineers. Director: C. E. Easter. Office: 40/42 Copthall Avenue, E.C.2.

# Company News

### Thomas De La Rue and Co., Ltd.

Profits of Thomas De La Rue & Co., Ltd., for the year ended last March rose by £114,000 to £660,000, and even after heavier taxation net profit was up by £67,000 to £254,000. A final dividend of 15 per cent on the doubled capital is announced, making with the interim of 20 per cent, a total of 35 per cent. This compares with a total distribution of 50 per cent for the previous year and requires the same gross amount.

### Johnson, Matthey and Co., Ltd.

In August last year when £2,000,000 of new money was raised by Johnson, Matthey & Co., Ltd., owing to the Government's proposed dividend control measure, issue of shares had to be made at 54s. instead of the 58s. intended, because the projected 15 per cent dividend on the enlarged capital would not have been permitted. A final dividend of 12 per cent for the year ended 31 March is however being made, bringing the total to the originally proposed 15 per cent. Group profit, after tax, at £580,429 fell slightly below the 1950-51 peak.

### Erinoid, Ltd.

Deferment of consideration of payment of the six months' dividend on the 4½ per cent redeemable cumulative preference shares due on 31 July next until the accounts for the year ended on that date are prepared, has been thought necessary by the directors of Erinoid, Ltd. These accounts are usually available in November. In the statement of the 1951 accounts by the chairman, Mr. C. E. Cleeve, reference was made to a falling-off in demand, which has been continued in all departments since last Christmas. A further consideration is the accumulation of excessive stocks of casein and considerable future commitments. For the year ended 31 July, 1951, a dividend of 12½ per cent was paid on the £357,500 of ordinary stock compared with 10 per cent on the previous year. There is £330,000 of preference capital in issue.

# Market Reports

LONDON.—The demand for industrial chemicals during the past week has been on about the same scale as for the past few months with deliveries against contracts going forward with fair regularity. New bookings are mostly limited to nearby requirements and the consumer demand for the textile, dyestuffs, paper making and plastics industries remains slow. Inquiries for shipment have been reasonably good in the face of keen competition from foreign suppliers.

Prices generally remain at recent levels with the exception of the quotations for the non-ferrous metal compounds. The prices given in this journal last week have been

lowered by £6 per ton. On the other hand the trend in the value of lead has been reversed and following the recent rise in the price of the metal, higher quotations have been notified for the red and white leads; the basis price for red lead being £195 5s., ground in oil £183; Orange lead £171 5s., ground in oil £195; White lead £170 5s., ground in oil £189; Litharge £159 5s.

GLASGOW.—Despite a quiet beginning, trade brightened up towards the end of the week but buyers on the whole are not prepared to commit themselves for forward delivery. The demand for chemicals for export remains steady.

JOHN KILNER & SONS (1927) LTD
ESTABLISHED 1867
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SPECIALISTS IN
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NORTON & RIDING
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*Chemical Plumbers & Leadburners*
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LEAD-LINED TANKS, COILS and VATS
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45, NEWHALL ST., BIRMINGHAM 3, *Tel: Central 6342/3*

# CLASSIFIED ADVERTISEMENTS

## SITUATIONS VACANT

*The engagemen of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged* 18-64 *inclusive, or a woman aged* 18-59 *inclusive, unless he or she, or the employment, is excepted from the provisions of the Notifications of Vacancies Order,* 1952.

**CHEMICAL ENGINEERS** for Process Design and/or Development Work are required by **THE BAHREIN PETROLEUM COMPANY, LTD.** Degree or Chartered applicants only considered, who must have had a minimum of three years' experience in this type of work. Salary in accordance with qualifications and experience, on successive two-year agreements with paid local and home leaves. Board, air-conditioned living accommodation and medical attention are provided in addition to salary, with low living costs, pension scheme and kit allowance. Age limits, 25 to 40 years. Apply, with full particulars of qualifications, experience, etc., to **BOX No. 5933, c/o CHARLES BARKER & SONS, LTD., 31, BUDGE ROW, CANNON STREET, LONDON, E.C.4.**

**CHEMIST** required for production and development of Phenolic Mouldings and Laminating. High salary plus opportunity for first class experienced chemist. Central London. Write full details to **BOX No. C.A.3155,** THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

**LABORATORY ASSISTANT** required by Med./Large Engineering Concern in Slough engaged in the manufacture of Motor Engine Components and Cork Products. A good opportunity for a young man who has completed his Military Service, work includes routine physical testing of jointings and allied products over a large range. Some previous knowledge of laboratory technique essential. Apply, in writing, stating age and experience. **BOX No. C.A. 3154,** THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

**POWER-GAS CORPORATION LTD.,** Stockton-on-Tees, have vacancies for the following :—

1. **RESEARCH CHEMIST** 1st or 2nd Class Honours degree or equivalent qualification essential. Graduates in Physical Chemistry preferred. Industrial experience desirable.
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Apply through the **MINISTRY OF LABOUR AND NATIONAL SERVICE EXCHANGE, BRIDGE ROAD, STOCKTON-ON-TEES.**

## CONSULTANTS

**CHEMIST, M.Sc., F.R.I.C., F.Inst.Pet.,** possessing small laboratory, assists industrial concerns with technical problems on individual fee or retaining fee basis. Wide practical experience with paints, varnishes, bituminous substances, resins, oils, pigments, fillers, emulsions, etc. **BOX No. C.A. 3153,** THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

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Auctioneers Valuers and Fire Loss Assessors of CHEMICAL WORKS, PLANT AND MACHINERY
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## FOR SALE

# 600

**CHEMICAL PLANT**

**"PULMAC" GRINDER** by Int'l. Pulverizers. Speed, 4,000 r.p.m. Motorised 400/3/50. Vertical concentric beater type mill with 12½ in. diam. chamber and two sets fixed beaters. Vibrator feed to mill centre.

Edgar Allen "Stag" **COMBINATION TUBE MILL,** 28 ft. × 5 ft. diam., divided by cast steel diaphragms into three compartments, one 4 ft. 6 in. long with stepped steel cast liners, one 5 ft. 9 in. long, and one 16 ft. long, both with C.I. bar liners. Mill rotates at 27.7 r.p.m. in 20 in. diam. × 16 in. swivelling trunnion bearings. Driven through David Brown reduction gear. Approx. 12 tons 2½ in.-1 in. balls available. Output when grinding coal, 4½ tons per hour, 85 per cent through 170 B.S.P. seive.

"Briton" **GRINDER,** type B.11 by Christy Norris. 24 swinging hammers on rotor shaft, 2½ in. diam. Feed aperture, 12 in. × 7 in. Motorised 400/3/50.

C.I. totally enclosed Unjacketed **MIXER,** 6 ft. int. diam. × 6 ft. deep on straight, 3 ft. hemispherical bottom, domed cover. Vertical glanded 4 in. diam. agitator shaft fitted two shrouded propeller type agitators. Fast and loose pulley drive.

Unused 30-gal. Stoneware **MIXER,** by Hathernware, totally enclosed and acid- and heat-resisting. Grouted in C.I. casing on a four legs. 1 in. centre bottom outlet. Fitted two Vitreosil 4kW. immersion heaters. Motorised 400/3/50.

S.J. **VACUUM MIXER,** by Bartle. Int. dimensions, 3 ft. 6 in. × 2 ft. 6 in. × 3 ft. 3 in. Perf. paddle-type agitators fitted to 2½ in. diam. shaft. 1 in. bottom outlets at each end. Close fitting lid, bolted. Fast and loose pulley drive.

Four **SIFTER MIXERS,** by Young. M.S. Mixing Trough, 64 in. × 21 in. × 22 in. deep. Blending chamber feeds material to positive action brush sifter. Fast and loose pulley drive.

**ROTARY VACUUM FILTER** by Davey Paxman. Drum, 33 in. × 36 in. diam., with stepped perfs. Fast and loose pulley drive through spur and worm gear.

Two Recessed Plate-type **FILTER PRESSES** by Manlove Alliott, with 54 plates 36 in. sq. × 1 in. thick. Hand-operated closing gear.

**EIGHT FILTER PRESSES,** plate and frame type, each with 51 frames forming cakes 29 in. sq. × 2 in. Individual plate discharge. Plates have ribbed surfaces.

**NEW** 1/16 h.p. Variable Speed Portable Stirrers, 200/250 A.C./D.C., 50-2,000 r.p.m. Stainless steel shaft 2 ft. long with two propellers.

**GEORGE COHEN SONS & CO., LTD.,**
**SUNBEAM ROAD, LONDON, N.W.10.**
**Tel.: Elgar 7222 and**
**STANNINGLEY, NR. LEEDS.**
**Tel.: Pudsey 2241.**

**ADVERTISERS** have for disposal 5 tons **REFINED PORK FAT** at £90 per ton, 10 cwt. Commercial **LANOLINE,** £6 5s. per cwt. 100 tons **MEAT** and **BONE MEAL,** £29 per ton. **BIRD'S, DUXFORD, CAMBS.**

**CHARCOAL, ANIMAL AND VEGETABLE,** horticultural, burning, filtering, disinfecting, medicinal-insulating; also lumps ground and granulated; established 1830; contractors to H.M. Government.—**THOS. HILL-JONES, LTD., "INVICTA" MILLS, BOW COMMON LANE, LONDON, E. TELEGRAMS: "HILL-JONES, BOCHURCH LONDON," TELPHONE 3285 EAST**

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| 130 off | MJ. 1" | 300 off | LJ. ½" |
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| 67 ,, | HJ. 45 | 22 ,, | HJT. 40 |
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Many other sizes in stock.

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**PHONE 98 STAINES**

"COCHRAN" Multitude Boiler, 9 ft. by 4 ft.; 850 evap.—100 w.p.
Twin "Z" and Fin Blade Mixers—Lab. sizes up to 10 cwt.
Two 4,000 gallon unused W.S. Enc. Tanks, 15 ft. by 7 ft. by 7 ft. by ⅜ in. plate.
Unused Condensers—"Weir" Brass Tubes—100 sq. ft. and six 3 ft. 6 in. by 5 in., with 325 ¼-in. copper tubes—various others by "Serck."
Stainless Steel Drum Mixer, 4 ft. by 2 ft. wide.
W.S. Jac. Pans or Mixers, 30, 50, 300 and 1,375 gallons.
Cyl. Rec. and Sec. Tanks up to 16,000 gallons.

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**DELAFILA, THE INERT FILLER.** Used in the manufacture of Fertilisers, Insecticides, Paints, Plastics and Insulating and Sealing Compounds. Prompt supplies in a wide range of fineness grades. **THE DELABOLE SLATE CO., LTD., DELABOLE, CORNWALL.**

EXCEPTIONALLY clean Vegetable Carbon from selected hardwoods. Graded, all passing ⅛-in. mesh, retained ⅜ in. Very clean, no dust. Powder and other sizes available. Write Box 876, Smiths', 100, Fleet Street, London, E.C.4.

**GRAVITY** Roller Conveyor several lengths, Rolls 2½ in. diam. by 16 in. 3 in. centres. Good condition **THOMPSON & SON (MILLWALL), LIMITED, CUBA STREET MILLWALL E.14.** (Tel.: East 1844.)

**SCREENLESS PULVERIZERS** for fine grinding of Chemicals. Also **CYCLONES, ROTARY VALVE FEEDERS. Callow (Engrs.) Ltd. Kirkby Trading Est., Liverpool.**

SURPLUS—m-2-xylidine, Nitro-methane, Calciferol, DL-Methionine, Haemin, Calcium hydride. Offers to **BOX NO. C.A. 3157,** THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

**TWO** 35 ft. long by 9 ft. diam. Lead-lined **TANKS.**
Stainless Steel **FILTER TANK,** 3 ft. 6 in. diam.
TWO Stainless **CONICAL HOPPERS,** 1,200 gallons, 8 ft. 3 in. diam., overall depth, 7 ft. 6 in.
TWO Broadbent **WATER-DRIVEN CENTRIFUGES,** 30 in. diam., 12 in. deep, 1,150 r.p.m., 150 lb. pressure.
FOUR Papier-mache O.T. **TANKS,** 8 ft. 6 in. diam., 8 ft. deep. (Unused.)
SIX O.T. **TANKS,** 7 ft. diam. 14ft. deep, lined inside with acid-resisting bricks.
SIX Aluminium **CONDENSERS,** 14 ft. long by 2 ft. 6 in. diam. 386 Tubes, ¾ in. o.d.
FOUR Rectangular Lead-lined **TANKS,** 8 ft. by 4 ft. 6 in. by 2 ft. 6 in.
FORTY Riveted **RECEIVERS,** 8 ft. 6 in. long, 5 ft. 6 in. diam., 75 lbs. w.p.
**CAST-IRON PIPES and FITTINGS,** 200 tons.
**VALVES** in Stainless, Gunmetal, Enamel Lined.
**Free Catalogue, "Watkins Machinery Record," available.**

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**VARIOUS MIXERS FOR SALE**

**TWO** Porteous **GRINDERS,** No. 4 Size, ball bearing, vee rope drive.

One Jeffrey **GRINDER,** 72 loose hammers, shaker feed.

Two Turner 2¾-sheet No. 2 **DRESSING MACHINES,** ball bearing.

Size No. 3 Junior Hammamac **HAMMER MILL** with fan and cyclone, also No. 1 size Miracle **GRINDING MILLS.**

Robinson 3-sheet No. 1 size **CENTRIFUGAL DRESSING MACHINE** for dry powders, etc.

Four **ROTARY BOWL MIXERS,** 5 ft. diam., cast-iron built, inclined agitators by Baker Perkins

One excellent **EVAPORATING UNIT,** comprising Copper Vessel, 4 ft. diam. by 5 ft. 6 in. deep, jacketed on the bottom, with copper swan-neck, C.I. catch-pot, vacuum pump and fittings including thermometer and gauge.

Large unjacketed **WERNER MIXER,** belt and gear driven, hand tipping, double "Z" arms, pans 31 in. by 45 in. by 36 in. deep.

No. 200 One nearly new **WERNER PFLEIDERER JACKETED MIXER OR INCORPORATOR.** Low type, with C.I. built mixing chamber. 28 in. by 29 in. by 27 in. deep, with double "U"-shaped bottom which is jacketed, and double fish-tail or fin-type agitators geared together at one side, with belt-driven friction pulleys, 34 in. diam. by 5 in. face, with hand-wheel operation and hand-operated screw tilting gear. Machine fitted with machine-cut gears, covers, gear guard, cast-iron baseplate, and measuring overall approximately 7 ft. by 6ft. by 4 ft. high to the top of the tipping screw

No. 209 One **HORIZONTAL "U"-SHAPED MIXER,** steel built, riveted, measuring about 8 ft. 3 in. long by 3 ft. wide by 3 ft. 3 in. deep, with horizontal shaft, fitted with bolted-on mixing arms about 18 in. long by 4 in. wide, with intermediate breakers, and driven at one end by a pair of spur gears, with countershaft, fast and loose belt pulleys, outer bearing and plug cock type outlet at the opposite end, mounted on two cradles fitted to two R.S.J. running from end to end.

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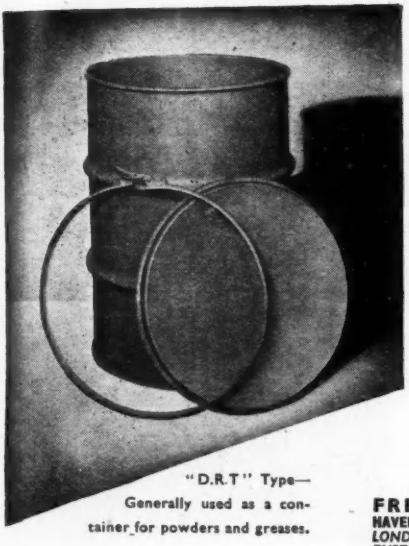

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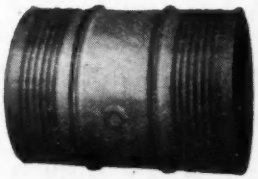

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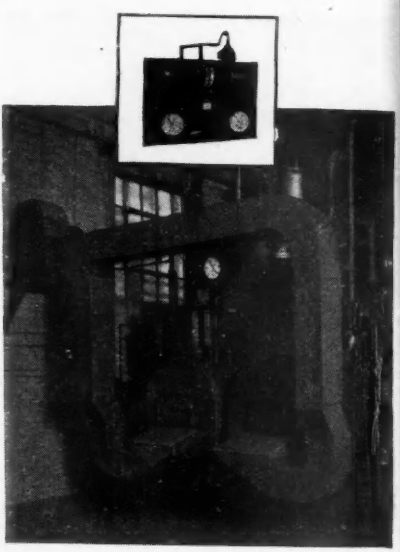

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